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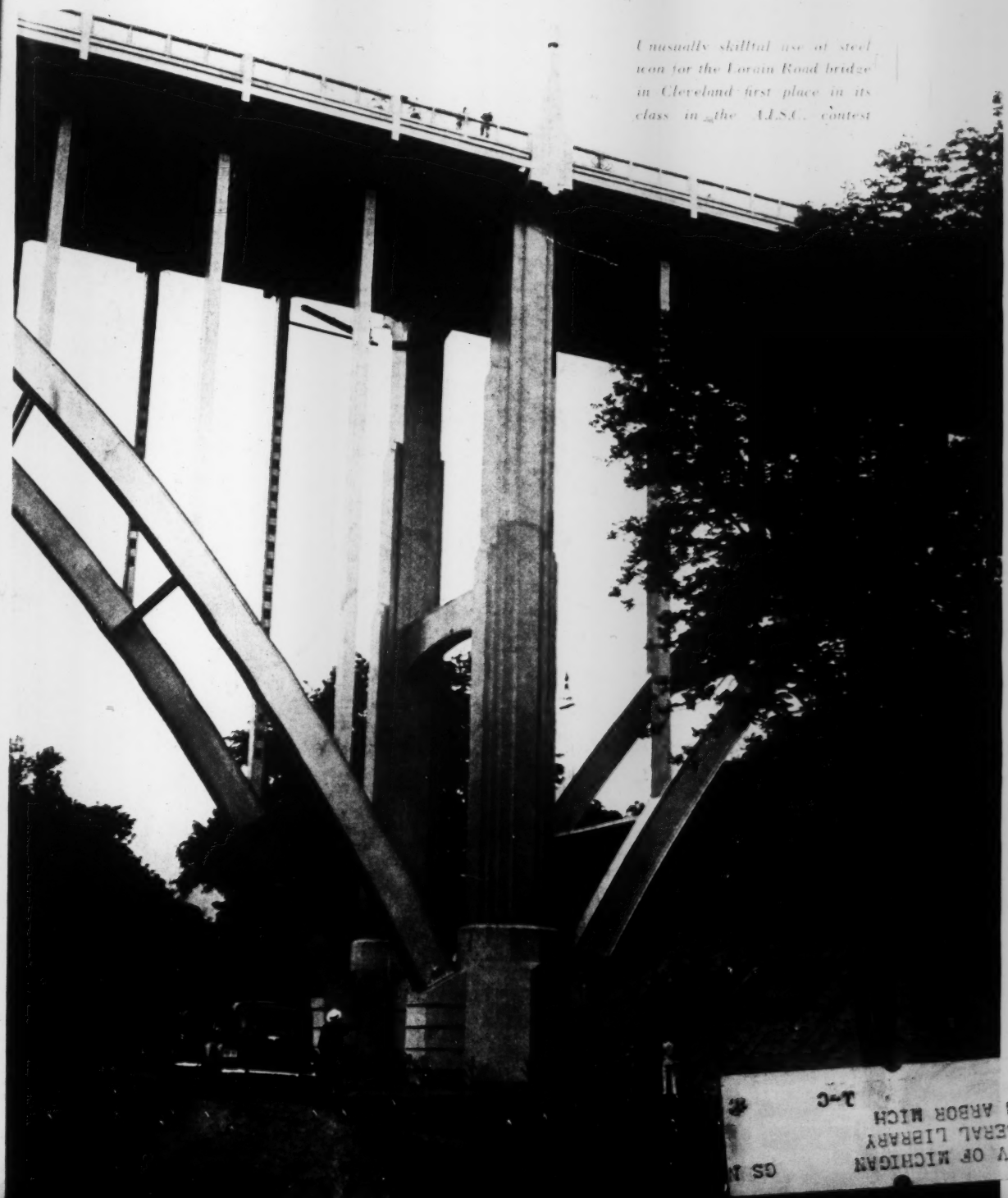

Unusually skillful use of steel won for the Lorain Road bridge in Cleveland first place in its class in the A.I.S.C. contest

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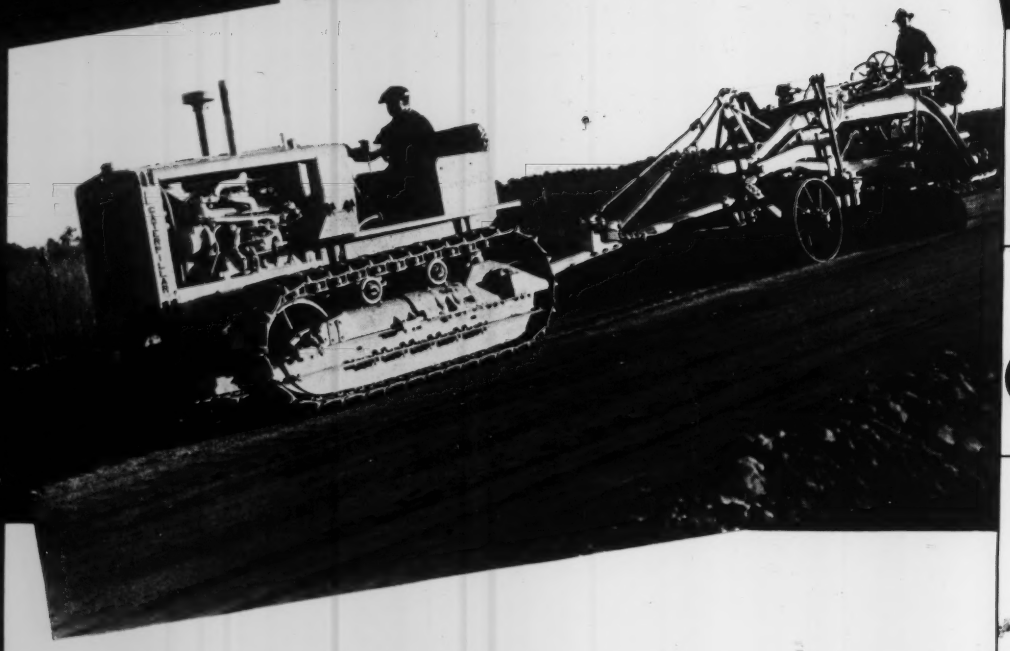

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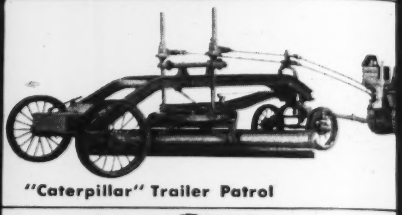

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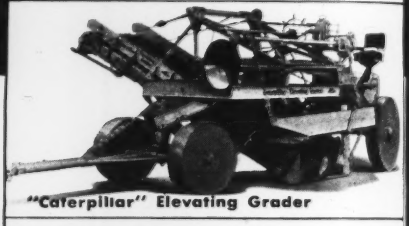

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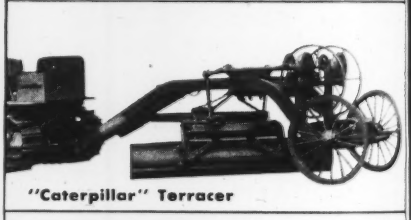

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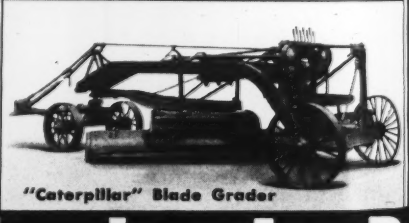

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So true is all this that we have come to take it quite for granted, indifferent to the marvel of so amazing a unity over the sweep of a nation so vast in area, so diversified in geography, climate and human activity. Sufficiently miraculous would it be if under such circumstances the bare necessities were made so readily available: but we find at every turn even the same luxuries in bewildering variety.

If your traveler be a technical man, concerned with the practice of industry, he is even more keenly aware of this companionship of familiar names and products. Whether he visit a mine or smelter in Calumet, Bisbee, Garfield or Anaconda, a steel mill in Pittsburgh, Pueblo or Birmingham, a power plant in Chicago, Cahokia, Dallas or at Boulder Dam, a breakwater under construction at San Pedro, an office building in New York, an aqueduct tunnel under San Jacinto, a highway in Idaho or a bridge in San Francisco, on all these jobs, thousands of miles apart, he finds the same equipment, bearing the same familiar names, performing the same functions and telling the same story of technical and economic progress.

WHAT is the source and explanation of such an accomplishment, unattainable only fifty years ago and incredible but a century ago? It will be found in no one factor; several have played important parts.

One of the first is the economic unity established by the Federal Constitution which insures to every producer his fair opportunity in a nation-wide market; another is the circumstance that but a century ago, when our people embarked upon the exploitation of their incalculable natural resources, modern technology also entered upon its astounding development. Others are implicit in the physical and economic conditions that have governed our national progress.

But of all these, one of the most powerful has been the coordination of technical and industrial thinking, the nation-wide interchange of experience, the almost instantaneous matching of scientific research, the unceasing accumulation of knowledge as to theory, practice, materials and equipment that have been made possible by the American technical and industrial journal. It is no accident that industrial journalism has achieved its highest standards in a land dominated by the urge to develop quickly so rich a national heritage: such conditions offered to industrial journalism an unprecedented opportunity; that journalism has helped to realize an unprecedented achievement in meeting those conditions.

Through its editorial effort to serve the well-being of creative and productive industry and through the opportunity it offers to manufacturers constantly to keep their products before industrial technicians and administrators, the American industrial journal does its indispensable part to conserve, stimulate and propagate the best thought of progressive industry and a widespread acquaintance with the materials and tools by which that thought may be turned to productive purpose.

WEEK by week, month by month, it ranges the fields of industry, seeking out and broadcasting to all that which can help to raise the general standard of performance. Thus is developed a nation-wide understanding and acceptance of sound practice and trustworthy equipment; thus is the experience of each made available to all. National unity and progress, industrial as well as social, must depend on the swift, continuous and nation-wide exchange of knowledge and experience.

Willard Chevalier

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Table of Contents—See Page 31

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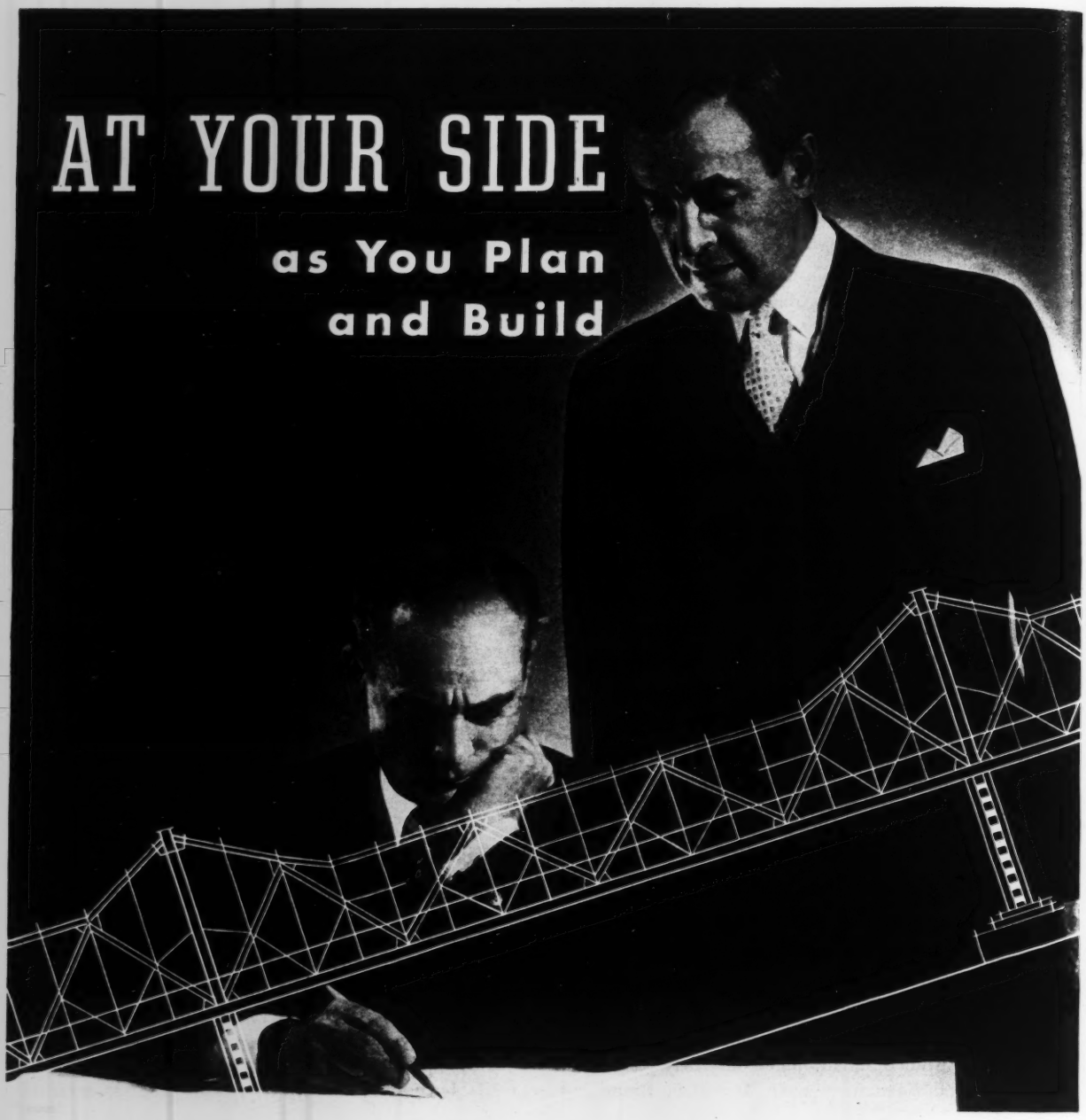

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C. S. Hill
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July 9, 1936

Architectural Factors in Arch Viaduct Design — *J. R. Burkey* — 37

Water Resources Committee Activities — 42

Age-Strength Relationship for Rammed Earth — *R. L. Patty* — 44

Priming the Construction Pump — *W. A. Klinger* — 45

Bypasses Box the Compass — *Walter O. Hill* — 47

Pollution Survey in Shellfish Waters — 49

River Measurement Stations Damaged by Flood — 50

Regulating Transport—V — *John S. Worley* — 51

Air and Water in the Southwest — 53

Soil Mechanics Conference—II — 54

Bascule Floor Modernized — 56

Report of A. S. T. M. Meeting — 58

Editorials — 62

Current News — 64

New Equipment — 70

■

Are Our Dams Safe?—When the St. Francis Dam crumbled and the flood of its released water devastated the peaceful valley below, California became conscious of its responsibility to make sure that its dams are safe. In six years' work since then the state engineering staff has made a thorough survey of 900 dams throughout the state.

- Major findings, the nature of the chief shortcomings, and the remedial work will be described in next week's issue.
- The outstanding fact is that one-third of all dams called for early repair or safeguarding.

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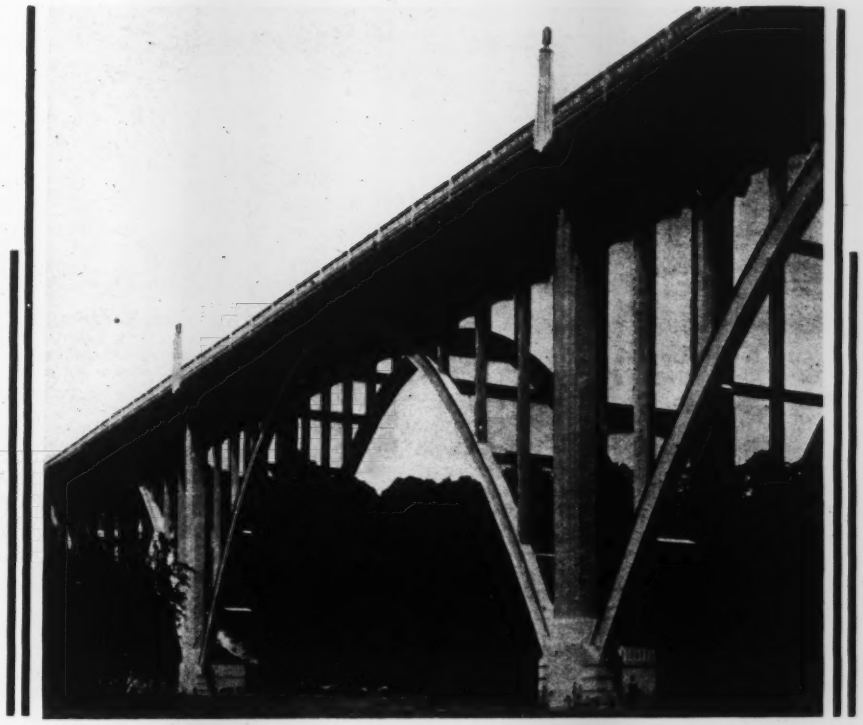


SIMPLICITY, smooth surfaces and dominating pier towers characterize the Lorain Road arch viaduct at Cleveland, a significant example of an attempt to design beauty into steel bridges.

Steel Arch Viaduct Design Governed by Architectural Objectives

Ohio state highway department's Lorain Road bridge at Cleveland introduces a new note in steel viaduct design.

By J. R. Burkey
Chief Engineer of Bridges and Railroad Crossings
Ohio Department of Highways
Columbus, Ohio

A STEEL VIADUCT of unusual design was recently completed at Cleveland by the Ohio department of highways. Located on Lorain Ave., state route 10, about 8 miles west of the center of the city, it crosses Rocky River and a portion of the Cleveland metropolitan park in a series of four arch spans whose design was largely predicated upon achieving a pleasing appearance. As a result, all cross bracing has been eliminated or concealed and only such rivet heads are permitted to show as are believed to aid the architecture and to be necessary to give honest expression to the riveted nature of the construction. At the same time a considerable amount of welding is used where it is logical and advantageous. The bridge was adjudged the most beautiful, in its price class, of any steel bridge constructed during 1935 in the competition announced by the American Institute of Steel Construction two weeks ago.

A steel bridge was chosen for the location since the state highway department had built three large concrete viaducts in the Cleveland metropolitan park area in recent years (*ENR*, Oct. 11, 1934), and felt that, if a design could be developed that would do justice to the natural beauty of the valley and its recreational use, steel should be considered from the standpoint of variety if nothing else. Preliminary estimates indicated that the cost of such a bridge would be comparable with that of any other suitable structure, especially when one took into account the length of the construction period during which all traffic would be interrupted on a busy thoroughfare. An arch type structure was chosen because of its adaptability to the topography and the site.

The new bridge consists of four two-hinged arches flanked by deck girder approach spans (Fig. 5). The two central arches are symmetrical and measure 256 ft. center to center of piers. The end arches were made unsymmetrical, to fit the natural topography, and have a span of 236.7 ft. There is a single girder span of 57.8 ft. on the east end and four 38.6-ft. continuous spans on the west end. The bridge is 1,260.9 ft. long overall and has

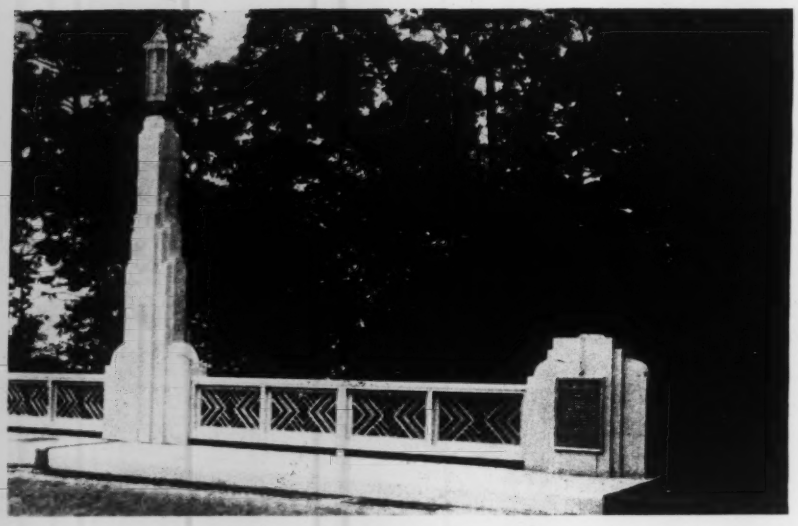


FIG. 2—MODERNISM in steel construction as expressed in the pylons and railings of the Lorain Road Bridge.

FIG. 3—CONTINUOUS GRATING along the curb line drains the deck into copper troughs that slope toward 8-in. pipe downspouts inside the pier tower legs.

a roadway width of 40 ft. between 5 ft. sidewalks. The height is 131 ft. from the bottom of the river under the east arch span to the surface of the pavement. The arch rise is 97 ft. The pier pedestals, and abutments, roadway slab and sidewalk slab are of reinforced concrete, and the roadway is paved with 3-in. brick on a granulated slag cushion. The footings extend an average of about 20 ft. below the surface of the ground and rest on shale.

Smooth surface arch ribs

The arch ribs, of box type, have a constant depth and section. The arch spans are identical except that the two unsymmetrical end spans are one panel shorter than the intermediate ones. All stiffeners and splice plates are concealed on the inside of the ribs and all joints in the cover plates and webs are butt-welded and ground smooth. All rivets, except in the flange angles, were countersunk, chipped and ground. Holes were placed on the inside vertical face of each rib, one in each panel, to permit access for construction, inspection and maintenance, and are equipped with flush cover plates secured with cap screws. The arch ribs are spaced 34.5 ft. center to center and are braced at each panel point with 36-in. rolled I-sections, the webs being placed normal to the rib axis.

Columns without lacing

The spandrel columns are closed on three sides and batten plates, 15 in. wide and spaced 15 in. apart, are used on the inner side. At the top and bottom of the columns, full plates instead of battens, are provided, to develop the stresses induced in the columns by the cross floorbeams, since the columns and floorbeams are designed to act together as rigid frames. The closed portion at the top of each column is filled with concrete to assist in resisting the compression induced by the action of the floorbeams, brackets and jack arches, which are framed into the four sides of the column. No bracing is provided for the spandrel columns, the longest of which is about 82 ft.

The floorbeams are spaced 19.3 ft. apart and the stringers 6 ft. The latter are designed for full continuity (Fig. 5), the connections between stringers being made by splice plates welded to the stringer flanges; the upper splice plate passes over the top of the floorbeam and the lower splice plate through a slotted hole in the floorbeam web. These connections were not completed until after the arch ribs were swung free of the centering.

Pier towers made prominent

The steel towers, which are placed over all arch pier pedestals, play an important part both structurally and architecturally. Each tower consists of two shafts connected at the top by cross-girders and also at mid-height except on the end towers. From the low concrete pedestals the shafts rise to the deck where they blend into the light standards, finally terminating with the ornamental luminaires about 20 ft. above the sidewalks. The vertical lines of the shafts are accentuated by avoiding any visible diagonal bracing and by concealing all horizontal joints and splices, as well as all rivets except the vertical lines of rivet heads at the corners. It is thought that the presence of the park, with its boulevard, drives and bridle paths, justified these refinements which affect appearance at close range.

The piers, consisting of the towers and the concrete pedestals, are designed as rigid bents to carry the full wind

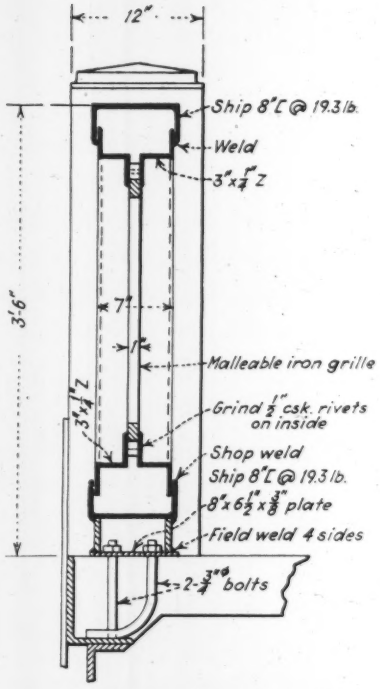


FIG. 4—RAILING of welded shapes with malleable iron grilles. A 5-ft. sidewalk and a 12-in. curb supplement the rail in its function of keeping cars on the bridge deck.

force from the arch deck to the ground, as no diagonal bracing other than within each shaft is provided. The transverse reaction of the deck is transmitted to the towers through flanged expansion plates. Two such plates are used at the ends of each span and are placed near the center of the roadway in order not to interfere with lateral expansion and contraction of the deck. The shafts are built of ½-in. plates and standard channels and angles. Each shaft is trussed on the inside and is rigidly anchored to a steel grillage extending

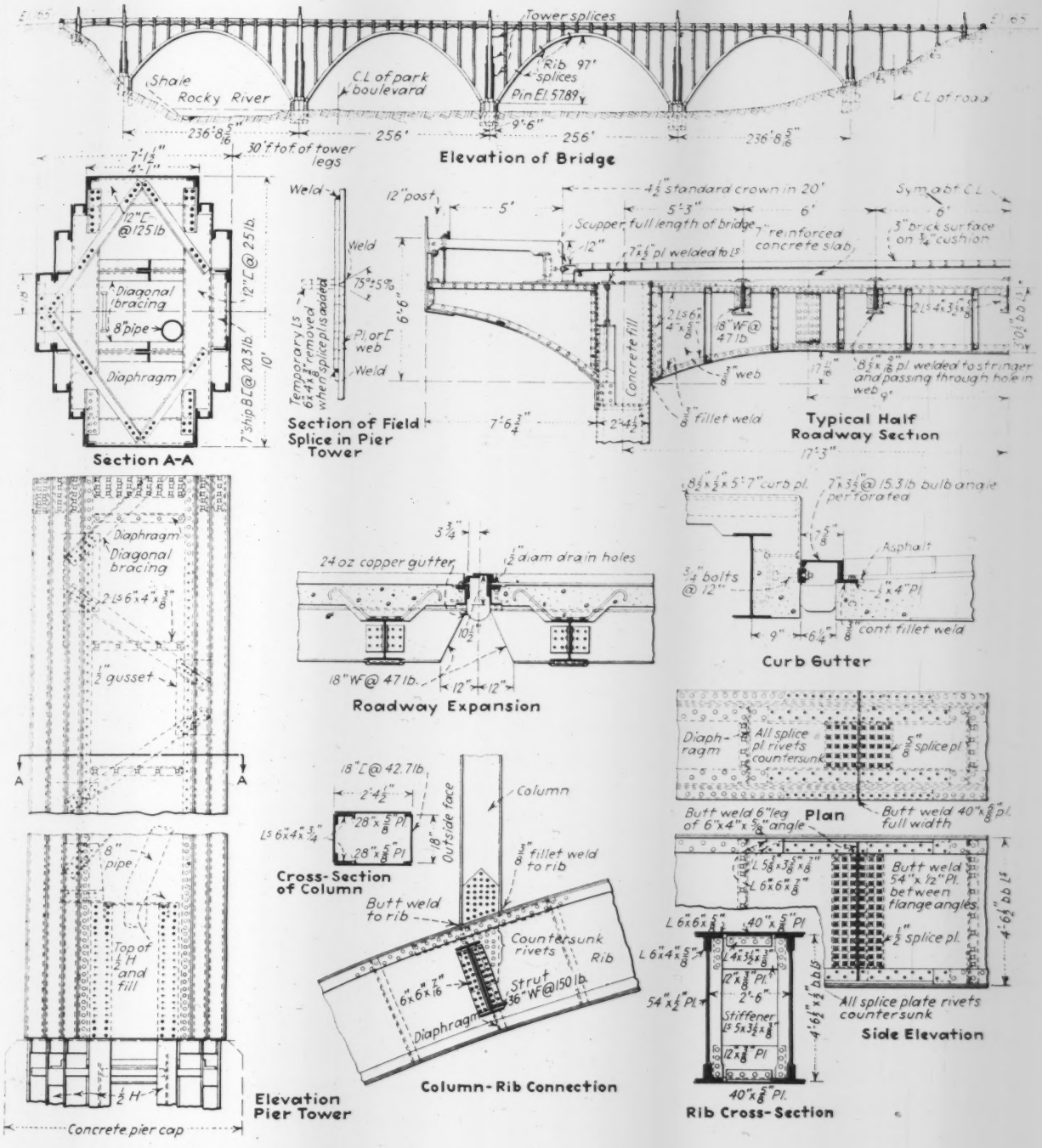


FIG. 5—STRUCTURAL DETAILS include countersunk rivets, welded joints, continuous stringers, rigid frame bents and novel gutters.

20 ft. into the concrete pedestal (Fig. 5).

Erecting the pier shafts

This grillage consists of half I-beam sections or tees braced and shop fabricated into pier units. The shaft was designed to permit it to be slipped over the grillage, which projects 5 ft. above the finished pedestals. The upper 5 ft. portion of the concrete pedestals was omitted until after the shafts were placed, to provide space for temporary steel supports for the shafts during erection. Steel shims of variable thickness were placed between the grillage and the shell of the shaft for the necessary field adjustments. Rivet holes in the shaft shells were shop punched but in the grillages and shims the corresponding holes were field drilled.

Access to the inside of the shafts is gained through manholes in the sidewalks and through steel doors near the base. Openings at the top and louvres on the door near the bottom permit circulation of air through the shafts, thus reducing condensation to a minimum. The shafts house the transformers and other electrical equipment as well as the conductor heads and downspouts for the drainage system. Steel ladders extend from top to bottom of all shafts, to facilitate inspection and maintenance.

The standards, which support the aluminum lighting fixtures (Fig. 2),

were fabricated from ⅜-in. plates and all joints are welded and ground smooth. Each lighting fixture is equipped with two 4,000-lumen lamps arranged one above the other on separate circuits. An automatic time switch is also used so that the lower lights may be turned off at any desired time during the night.

Malleable iron rail grilles

The metal railing was designed to give a sturdy appearance and to harmonize with the modern motif used on other portions of the structure. Each panel consists of four malleable iron grilles, 1 in. thick, set in and riveted to a welded steel frame built up of 3-in. zee sections and 8-in. ship channels (Fig. 4). All of the welded joints were chipped and ground. All rivets on the roadway side of the railing were countersunk. The finished railing weighs about 100 lb. per lineal foot.

The bridge is on a level gradient, to fit the approach elevations, which necessitated the development of a special drainage system since open scuppers would have been considered objectionable over the park. The solution is depressed copper gutters (Fig. 5) installed in continuous longitudinal openings left between the roadway slab and each sidewalk, to form closed scuppers. Sufficient gradient was provided in these gutters, by using a trough section of variable depth, to conduct the water to the piers where it is dropped into an 8-in. steel pipe down the inside of the pier shaft to a sewer laid under the centerline of the bridge. The copper gutters are protected by steel gratings (Fig. 3) built of bulb angles, punched with slotted holes and made in lengths of from 6 to 8 ft. The gutter is also designed to permit drainage of any water which seeps into the cushion under the bridge surface course. A transverse copper trough is also installed under each expansion joint between spans.

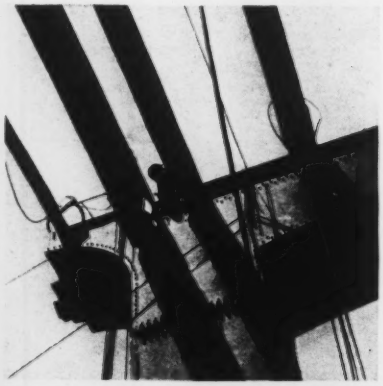
Many splices and connections in the structure were both riveted and welded, such as those in the arch ribs and pier shafts. The welding in such cases was always done first so that initial stresses would not be developed in the rivets due to the shrinkage of the weld metal. All welding was done by the electric arc process, using coated electrodes.

In the erection of the viaduct, a stiff-legged derrick operating from deck level was used to place all structural steel in the end approach spans and the end arch towers including as much of the end arch spans as could be reached from the end tower position. Two other stiff-leg derricks operating on runways at ground level, one on either side of the structure, were used to erect all intermediate steel in the four arch spans that could not be reached from the tops of the two end towers.

Steel centering was used in the erection of three arch spans and timber centering for the other, the latter being added to hasten completion. Each rib was erected in seven sections, the longest being 50 ft. and weighing 17 tons. Wood blocks and wedges were used to support the ribs on the centering, the individual sections being raised or lowered to their proper elevations by means of jacks.

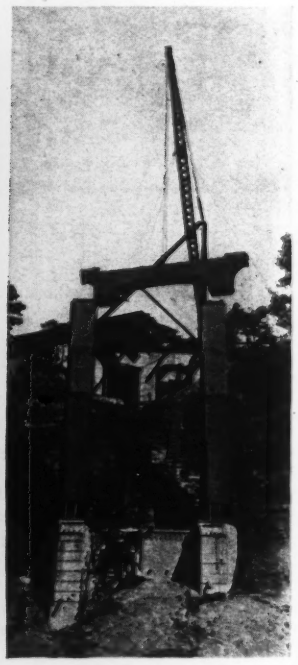
The end tower shafts were each erected in two vertical lifts, the longer intermediate shafts in three. The cross-girder sections joining twin shafts were erected in one piece. The largest tower sections were 54 ft. long and weighed 26 tons. Each spandrel column was fabricated and erected in one piece.

FIG. 6—ERECTION SCENES on a unique steel arch viaduct. Because of the absence of diagonal bracing on the Lorain Road Bridge a considerable number of temporary guy cables were necessary prior to the erection of the floorbeams and the placing of the concrete deck slab.



Temporary bracing

As the finished structure depends on the concrete slab for the transfer of the lateral forces to the towers, it was necessary during construction to install temporary diagonal bracing between floorbeams, which was left in place until the deck concrete had attained its required strength. Temporary diagonal bracing was also used between arch ribs and between spandrel columns, to hold the bridge in line during construction and to avoid excessive construction stresses.



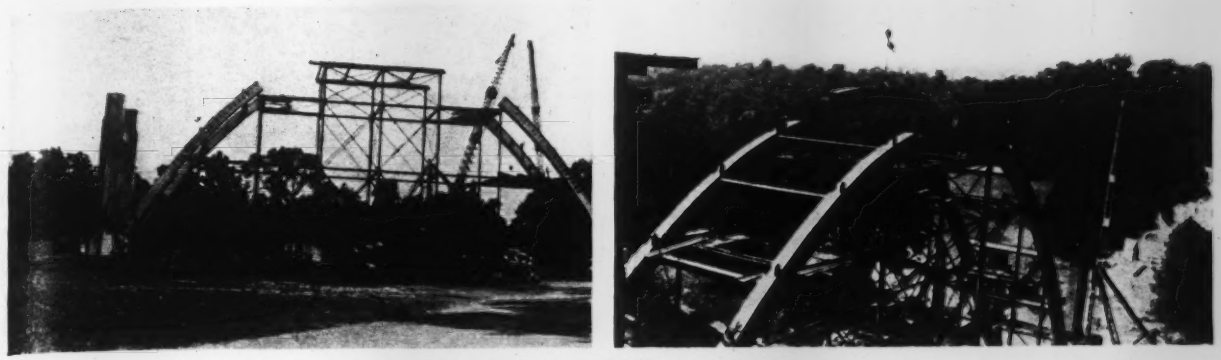


FIG. 7—ARCH ERECTION on steel falsework using steel stiffleg derricks.

The absence of permanent diagonal bracing between ribs, the small dimensions of the rib section in relation to fabricated lengths, and the omission of milled joints, which would have been unsuitable for the butt-weld used to join sections, made the erection of the ribs a delicate problem. Alignment was carefully controlled by transit while elevations were established by vertical measurements from ground points to a bolt in the top hole of spandrel column gussets.

In order to prevent excessive footing pressures from eccentric loading during construction, the specifications required that no concrete be placed on any arch deck until all structural steel in the adjoining spans was in place and free from the falsework. To prevent undue distortion of the arch ribs, the roadway slab for each span was placed in five sections in the following order: two and one-half panels at each end, four panels at the middle, and finally, the remainder near the quarter points. The concrete sidewalks were placed after the roadway slab had been completed and thoroughly set. This procedure, it is believed, minimized stresses in this thin section due to composite action with the remainder of the structure and facilitated refinement of construction in this conspicuous part of the deck.

Asphalt emulsion waterproofing was applied over the roadway slab. This also served for curing and was applied with spray guns. The first application was made as soon as the concrete had hardened sufficiently to bear the weight of workmen, followed by two other applications at 24-hr. intervals, using a total of about 0.5 gal. per square yard.

As the color of a structure has such a decided influence on its appearance, considerable study was given to the final coat of paint. For the shop coat sublimed blue lead was used. Two such shop coats and one field coat of white lead were applied to the interior of the arch ribs. All other surfaces were painted one shop coat and two field coats except the railing and light standards which received an additional color coat. The first field coat for the interior of the towers was blue lead and for all exterior surfaces tinted white lead. The second field coat for all exterior parts, except cross struts between arch ribs and certain portions of the railing grilles, consists of white lead tinted to make a light greenish gray, with sufficient yellow added to produce a warm neutral tint. The horizontal cross struts have a darker and more subdued shade of the same color, to accentuate the vertical lines of the bridge. This darker shade as well as an intermediate shade are used on certain portions of the railing grilles to produce a three-tone repeating pattern.

Administration and personnel

The contract for the bridge and approaches was awarded to the Lowensohn Construction Co., Cleveland, in November, 1934, for its low bid of $535,472 by O. W. Merrell, who was then state highway director. The bid for the bridge was $496,341 and for the brick-paved approaches and landscaping $39,131. The structural steel was fabricated by the Fort Pitt Bridge Works, at Canonsburg, Pa., and was erected by the Peoples Steel Co., Cleveland, both acting as sub-contractors.

Active construction did not start until March, 1935, and the bridge was opened to traffic in December of the same year, although some of the field painting and landscaping were delayed until the following spring.

The work has been carried on under the supervision of John Jaster, Jr., director of highways; G. M. Anderson, assistant director; J. R. Burkey, chief engineer of bridges; Elmer Hilty, chief engineer of construction; L. L. Drasler, division engineer; and J. O. McWilliams, resident engineer. The design was prepared in the bureau of bridges of the Ohio department of highways; W. H. Rabe is chief designing engineer and D. H. Overman was the principal designing engineer in charge of this project. Those engineers who had a principal part in the construction of the bridge are R. R. Heckman and R. L. Keller. The right-of-way was provided by Cuyahoga County.

Road and Street Program Largest WPA Activity

WITH THE ARRIVAL of warmer weather the WPA has continued its road and street program as its largest relief employment activity. During February there were 1,163,927 persons employed at an average of about 37c. an hour on some 26,400 road and street projects.

On the basis of February statistics, the latest month for which figures are available workers on road and street programs represented 38.3 per cent of the 3,038,973 persons then working on WPA projects. Of the $1,367,839,799 worth of projects selected for operation through March 16, the sum of $503,363,376, or 36.8 per cent of the total, went for this type of project. Of this sum, $160,221,587 represented farm-to-market and other secondard roads, and $343,141,789 represented other highways, roads and streets. There were 422,417 persons or 13.9 per cent of the total WPA employment engaged in the farm-to-market road program and 741,510 on the other types of roads in February.

There are 11,556 farm-to-market road projects as compared with 14,928 other road and street projects in cities and small towns. The total amount of money to be contributed by local sponsors reached $111,000,000, or 22 per cent of the total cost of the road and street program, as compared with a 16.5 per cent average for all other WPA projects. Sponsors of farm road projects contributed 27 per cent, or $43,321,890 of the total cost, compared with 20 per cent or $68,446,057 contributed by sponsors of other road and street projects.

Activities and Aims of the Water Resources Committee

In pursuing its major objective of coordinating operations of central and local agencies concerned with water resources development, the committee is concerning itself with basic hydrologic data, balanced river regulation, stream pollution, drainage and water storage

THE ESTABLISHMENT of the Water Resources Committee of the National Resources Committee is a result of a series of national events in the last five or six years. Under the pressure of emergency expenditure, important activities in the field of water use and control gave rise to the Mississippi River Valley Committee and to the Water Planning Committee. The report of the Mississippi Valley Committee presented a broad policy of water development in one of the largest areas of the United States and that of the Water Planning Committee a rapid inventory of the present resources and data. The creation of the Water Resources Committee was intended to carry forward the activities of the previous committee and the coordination of federal and federal-local activities in water planning and development. These and the following facts have been extracted from a paper by Abel Wolman, chairman, Water Resources Committee, presented at the meeting of the American Water Works Association in Los Angeles on June 9.

Federal interests in water uses

The interests of the federal government in the use and control of water are complex and highly diversified. During the last 16 years progressive diversification of federal water resources work has occurred until now there are over 35 individual agencies concerned with this phase of work. In 1920 river and harbor improvements constituted approximately three-quarters of all federal expenditures, and irrigation and flood control work accounted for the greater part of the remainder. In 1935 an entirely different picture of relative allocation appeared which may be of considerable national significance.

Navigation and flood control work had grown to far greater dimensions. Irrigation had increased to a lesser degree but the dominance of these activities in the federal construction field had been lost. Wild life and recreational projects had gained in importance. By virtue of emergency activity the most significant changes were the additions of municipal water supply, sewerage and sewage treatment and multiple purpose projects. The last group represented federal undertakings designed to serve more than one use, with the development of hydro-electric power as perhaps the most common of the multiple uses and exemplified in such projects as Boulder Dam, Bonneville, Grand Coulee, Norris Dam and Madden Dam.

Many people interested in the problems of water resources of the nation have been perhaps unaware of the profound changes in the engineering, administrative and financial structures of the water resources field. A rational and orderly development and use of these resources has become more and more of a necessity as operations in this field have extended.

The axioms that the most beneficial use of water resources in any valley should be related to the development of other physical resources, that development of any one phase of water resources should be considered in relation to all other phases, that physical factors are of importance in relation to cultural and economic conditions, and that present as well as future aspects should play a part in any program, must lead to the conclusion that competent administrative authority over water use and control is necessary for the determination of equity, for the establishment of the most equitable allocation of uses and for putting into effect the results of such studies.

The Water Resources Committee was organized on July 24, 1935, as a successor of the former Water Planning Committee and the Water Resources section of the National Resources Board. It now constitutes an agency of the National Resources Committee and is engaged in the collection of basic hydrological data, the regulation of conflicts of interest or purpose, the extension of basic information, the development of drainage basin economies and, as a natural result thereof, the prompt promulgation of work priority lists which would fit into the gradually crystallizing pattern of drainage basin economy.

The committee consists of twelve members, three from the former organization and nine new members. Eight federal agencies and two state agencies are represented.

Obtaining basic data

The former Water Resources Section organized a special advisory committee on standards and specifications for hydrologic data, composed of representatives of federal agencies which collect such data and representative engineers who use them in private practice. The first report of that committee, concerned primarily with the establishment of standards which are of broad application and permanent value, has been published.

Sound practice in the design and construction and operation of water use and control works is determined in large manner upon reliable hydrologic data. The special advisory committee mentioned above has made an inventory of all hydrologic data collecting work now carried on by federal agencies and it has reviewed that work from the standpoint of engineers, farmers, waterworks and power plant operations, and others who use such material. In the light of this investigation and of present experience, the following recommendations were made: (1) Rehabilitation of an increase in the number of precipitation recording stations, (2) the establishment of at least 500 snow survey courses in mountain areas, (3) the establishment of 500 federal base stream gaging stations and 600 cooperative secondary stations, and the rehabilitation of 1,000 old stations, (4) the installation of 10,000 wells to study the extent and fluctuation of groundwater, (5) further studies on evaporation and (6) systematic collection of data on the quality of surface waters.

The total cost of the program recommended for the correction of important deficiencies in our knowledge of water resources would be insignificant in comparison with the savings made and the potential damages averted.

Coordination of conflicting interests

One of the first problems confronting any group interested in adequate water resources control and use is that of coordinating the conflicting purposes and methods of both federal and state agencies. Because of the intensification of some of these conflicts in recent years, due primarily to vast expenditure of emergency agencies, the Secretary of Agriculture on Aug. 9, 1935, requested the National Resources Committee to review the operation of some twelve to fourteen federal agencies with a view to determining the character of their land drainage and water storage programs and methods, with particular reference to wild life, pest control, malaria control and reclamation.

The Water Resources Committee, therefore, on Oct. 29, 1935, appointed a special subcommittee on drainage policy and projects to report on the question. The report of this committee, made on Jan. 14, 1936, indicated that conflicts of federal activities in drainage and storage work resulted in unnecessary waste and delay. It was also stated that most of these conflicts might have been prevented had there been an opportunity for reconciliation of policies during the planning of the various programs. As a result of this survey, the President

issued an order to existing federal agencies concerned with projects or allotments for land drainage or water storage on Feb. 1, 1936, in which he instructed the appropriate officials to submit a statement of impending programs of such work to the National Resources Committee at regular intervals in order that other agencies having an interest in the work could be informed by the committee of the programs well in advance of their initiation. It is apparent after only a few months operation, that this effort at coordination is proving highly successful.

Water pollution reviewed

Another activity of the National Resources Committee is outlined in the report of the special advisory committee on water pollution, issued in July, 1935.

The increasing importance of water pollution by domestic and industrial wastes led the National Resources Committee to request a review of the legal, public health, biological, industrial and financial aspects of this difficulty. As half a century ago navigation was perhaps the most important consideration in the public eye with respect to rivers, so in recent years water pollution is gaining more and more importance in public discussion and in the effort toward regulatory control.

The committee in its report recommended the following policy:

(1) That where drainage area authorities exist for the comprehensive development and control of water, their scope be made sufficiently broad to include the control of pollution.

(2) That no basic changes in existing federal law with reference to water pollution control be made until an experimental program shall have indicated whether or not such changes are desirable and feasible.

(3) That simplification and coordination of state laws be effected to provide for the following minimum requirements:

a. Adequate administrative control
b. Delegation to the administrative agency of power to determine the nature and extent of pollution prohibited by the statute, and to establish limitations of pollution.
c. Appropriate mandatory powers, particularly the power to compel the installation of essential remedial works and force other necessary action.
d. No limitation on the taxing or bonding power of municipalities when applied to remedial works.
e. Power to require facilities through sewerage districts, sanitary districts or otherwise, that will enable municipalities and industry to comply with the law.

(4) That broader authorization for research be granted those agencies of the federal government which already are concerned with various phases of the problems.

(5) That powers and funds be granted to an appropriate federal agency to institute a cooperative program of investigation with legally constituted state agencies for special studies as appear desirable.

(6) That in order to stimulate the construction of pollution abatement works, funds for the purpose be made available by the federal government to local, public and private agencies on a grant and aid or loan basis. Lacking any precedent for the designation of appropriate bases for such allocations, the committee recommends the creation of a demonstration unit on a river system selected for that purpose.

Balanced river regulation

Recent dramatic emphasis on the droughts and floods has concentrated attention more and more on the all embracing problem of river regulation. When floods occur and damages are great, the public rushes to Congress for flood protection works. Their character and adaptability to the remaining program of stream regulation are lost sight of in the desire for immediate correction of serious difficulties.

In view of this tendency to ignore the necessities of balanced development of any drainage basin, the Water Resources Committee has considered the relation of various proposed investigations concerning floods and flood control and recommended the issuance of executive order or memorandum designating the National Resources Committee as a clearing house for information on flood study. (This order has just been issued.)

Special problems in the waterworks field have also been under study and reports thereon should materialize from time to time. Detailed attention is being given to the water problems of the arid and semi-arid Western States.

An effort is likewise under way on the part of the committee to simplify the collection of waterworks statistics throughout the United States. For some years in the past, data on various aspects of water use have been collected by a variety of unofficial and official national agencies. Duplication of material and of use, irritation of local groups and conflict of purpose, all indicate that some effort at coordination would be helpful.

Another enterprise in which the Water Resources Committee has recently been requested to act is concerned with the reconciliation of the preparation of manuals by the various federal agencies on the design, and construction of small dams. At the request of the several federal agencies, the committee has undertaken the task of reviewing and coordinating a number of manuals on this subject which have been in use over a number of years.

Special assignments

Most of the above discussion has been restricted to the operation of the committee on general problems concerning the country as a whole. Among its activities, however, it has undertaken specific studies where conflicts of interest or purpose have become so great that requests for external review by the National Resources Committee have appeared. In this connection, a study is now being conducted on the upper Rio Grande basin above El Paso involving the coordination of water use. A similar study, requested by the State Planning Boards of Minnesota, North Dakota and South Dakota, is being made on the Red River of the North. In cooperation with the U. S. Army Engineer Corps and with state and local cooperation, the Water Resources Committee has contributed its efforts from time to time to a study of the flood protection program at Kansas City.

Tentative future program

It should be clear from the brief description of the forms of activity which the committee now has under way that the major effort of the committee should be permanently restricted to the task of planning, coordinating and stimulating the operations of central and local official and unofficial agencies. Much of the probable value of the National Water Resources Committee may easily be lost or diverted if the committee embarks upon operating administrative functions which should be restricted properly to existing or new administrative agencies. The energies of the Water Resources Committee should not be diverted to detail of administration and the membership of the committee is completely in accord with the desire to restrict its operations to those functions noted above.

A considerable extension in the collection of basic information regarding water resources is necessary for the most fruitful development of our water resources. The committee intends to stress this necessity regularly and continuously.

Revised Asphalt Specifications

SPECIFICATIONS for three types of asphalt road have just been issued by the Asphalt Institute, New York City. The construction specifications are for the following road types: surface treatment—original treatment of tightly bonded surfaces, such as water-bound macadam, clay gravel, sand clay, shale and limerock; surface treatment—original treatment over loosely bonded surfaces such as traffic-bound macadam; base—patching, reducing crown and correcting profile of old surfaces.

Specifications now available from the Institute include: asphalt macadam surface, asphaltic concrete surface, stone-filled sheet asphalt surface, sheet asphalt binder and surface, patching and reducing crown, asphalt macadam base, asphaltic concrete base, asphaltic road-mix surface course, asphalt surface treatment, surface treatment of water-bound surfaces, and surface treatment of loosely bonded surfaces.

Age-Strength Relationship For Rammed Earth

Tests at South Dakota State College reveal an increase in strength of as much as 45 per cent in 2 years for the best soils which contain large per cent of sand

By R. L. Patty

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RAMMED earth or pisé walls increase in strength with age in the same way as concrete. In an experimental study of this material at South Dakota State College (Bulletin 277) it was noticed that earth walls became tougher and more resistant to driving rains and weathering after they had stood for a time. The question then arose as to whether the strength of this material might not also increase, although the material is known to dry out to constant weight within ninety days under laboratory conditions. A test was made, therefor, on the relation of age to the strength of this material, the test covering a period of two years.

Rammed earth walls are monolithic walls made by ramming a barely moist earth into a form similar to that used for a monolithic concrete wall. No cement, lime or admixture of any kind is used for a binder, and the soil that will make the best and most durable wall will contain a considerable amount of sand and not more than 20 per cent of clay. A single section of plank form is used for building the wall. After a section of wall is rammed, the form is moved along the wall and a second section rammed. A tongue and groove joint is made between sections so as to make the wall tight and warm.

This type of wall has been used in almost all parts of Europe, even back to ancient times, and today interest in it is increasing, especially in Sweden, Norway and the northern part of Europe. It is a most durable material, there being records of such walls that have stood for hundreds of years resisting fires, storms and earthquakes.

In the South Dakota State College test three base soils were used and twelve test blocks were made from each soil on the same day and from the same pile of earth. The first was a very heavy clay soil; the second a medium sandy soil; and the third is a very sandy soil. At the end of six months four blocks of each soil were tested to failure. At the end of one year four other blocks of each of the soils were broken and at the end of two years the final four blocks of each soil were broken. Upon averaging the strength of each group of test blocks an increase in strength was shown in the case of each soil. At the end of one year the average increase in strength over the six months test blocks was 33.7 per cent. At the end of two years the average increase in strength over the six months blocks was 45 per cent.

It is interesting to note that the heavy clay soil has the greatest early strength, and this has been found true throughout the study which has covered a period of six years. It is still first in strength at the end of the two years but the results in the accompanying table show that the sandier soils gained more strength with age. This clay soil is not a favorable soil for pisé walls in spite of its superior strength because it has a tendency to slake in the wall and does not resist the action of weathering as well as the soils containng less clay. Of the three soils used in this strength test, soil No. 3 containing 74.82 per cent of sand makes the best wall by far, while soil No. 2 makes an average wall.

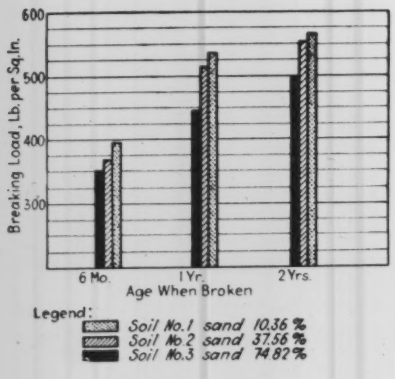
The test blocks were rammed in the laboratory in a small form with dimensions of 9 in. x 9 in. x 9 in. In order to control the human factor in the test, two forms were provided, two experienced men were used for ramming the earth and with each alternate layer of earth rammed, the men changed forms. The optimum moisture was used for each of the soils. Since it is difficult to read the incipient load in testing this material, the blocks were tested to complete failure and the utlimate load was recorded in all tests. Previous testing of earth blocks has shown that the average tests from four test pieces will give a reliable result figure. In this particular study the breaking loads ran quite uniformly. The strength figures recorded for these three soils are slightly below the average for the many types of soils that have been tested for strength at the South Dakota Station. The highest strength shown by a natural soil in a similar test block up to the present time is 877 lb. per sq.in. at the age of two years.

EFFECT OF AGE UPON STRENGTH OF RAMMED EARTH

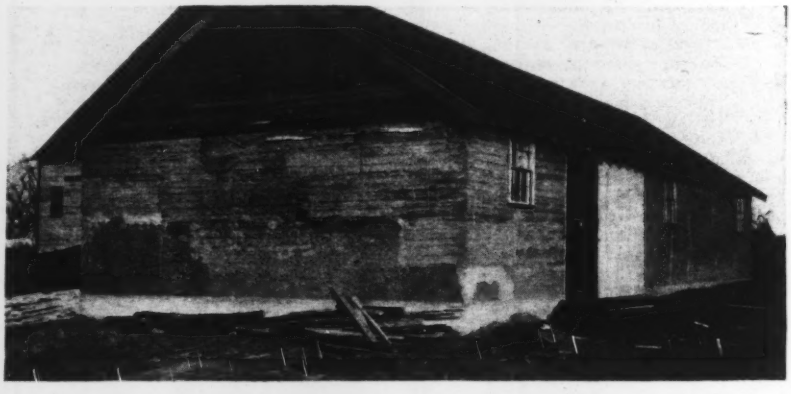
(All tests for compressive strength in pounds per square inch)

Soil No.	% Total Sand Over No. 200 Sieve	Av. Strength at Six Mos.	Av. Strength at One Year	Strength Increase Over Six Mos.	Av. Strength at Two Years	Strength Increase Over Six Mos.	No. of Blocks in Series
No. 1	10.36	396.9 Lbs.	533.0 Lbs.	34.4%	569.8 Lbs.	43.5%	12
No. 2	37.56	371.5 Lbs.	522.8 Lbs.	40.8%	560.7 Lbs.	50.7%	12
No. 3	74.82	353.3 Lbs.	445.9 Lbs.	26.3%	497.1 Lbs.	40.7%	12
Ave.	.....	373.9 Lbs.	500.6 Lbs.	33.7%	543.2 Lbs.	45.0%	..

RELATION of age to strength in rammed earth walls.



RAMMED EARTH WALLS as used in a farm building. The walls are 12 in. thick and will be given a protective covering of stucco.



Priming the Construction Pump

An appraisal by a practical general contractor of the construction business and present recovery economics

By W. A. Klinger

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Condensed from an address delivered Feb. 19, 1936, before the Builders Association of Kansas City, Missouri. The date of this address limited consideration of recovery financing to the beginning of this year and since then a new appropriation of $1,425,000,000 has been granted by Congress.

IN RECENT YEARS economists and politicians, for purposes of comparison, have fixed upon the year 1926 as a normal one and as the statistical base for the drive toward economic recovery. In that normal year construction presented a far different picture than it does in these times.

As we look back upon it now, the industry was then completely immersed in work. Construction was as abundant as the times merited. In volume, it was the second only to agriculture, and it and its allied industries offered employment to one out of every six male employables in the nation. In those days, the industry was a good place in which to make a living; a place where courage, determination and diligence were bound to produce success, because a man working in the industry had within himself the making of his own career. His relations to the industry were determined within himself. His market was a wide one, his customer was of his own choosing, his worries were confined to his own working forces, and to his competitors. Although the final rewards were not what they should have been when compared with other industries, that was a problem recognized as inherent in the industry.

SUCH was the construction industry in the period which ended with 1929. In four years from 1926 to 1929, there was an average of $9,250,000,000 per year expended on construction, with 1928 as the peak year, producing $10,500,000,000 of work. In the past four years, we have had an annual volume of less than $3,000,000,000, an average of less than one-third of the former normal volume. In spite of the seemingly tremendous efforts of the administration, construction volume since 1932, when it was $2,800,000,000, has seen but little change, and the consensus of available figures for 1935 places it at $3,200,000,000. There is, however, this striking difference: For 1926, public works construction totaled roughly $1,800,000,000 and private construction totaled $7,500,000,000; in 1934, the figures were reversed, the construction total was only $3,000,000,000, of which 80 per cent was either partially or wholly financed by the United States government, and 20 per cent was private construction.

Much public construction

The public construction program of 1935 was somewhat less than that of 1934, largely because of the construction projects undertaken in 1934. Taking the nation as a whole, privately financed work in 1935 increased over that in 1934; there was about a 50 per cent increase in commercial and industrial construction, and about an 80 per cent increase in residential units. However, since commercial construction was 20 per cent of normal, a 50 per cent increase brought such work to only 30 per cent of normal, and similarly, residential construction had dwindled down to 10 per cent of normal, so that an 80 per cent increase brought it to 18 per cent of its usual volume.

These figures show that as we open the year 1936, we find that the United States government, through wholly or partially financed work, has become the purchaser of 75 per cent of all the construction being sold in the nation. The usual liberal flow of private work becomes a trickle.

Congress primes the pump

Some three or four years before the crash, the A.G.C. had advanced the theory that construction was the balance wheel of industry, and that in times of business depression, governmental agencies should balance industry by increasing public works construction. The principle was sound. When an effort toward reconstruction of the nation's business structure was undertaken in 1933, this idea was seized upon, not as a principle based on sound economics, but as a theory, and as a theory it has been experimented with ever since. It has been given the euphonious title "Priming the Pump," the theory having been that once the pump is primed, business will carry on.

In 1933, we witnessed the first effort of the administration to prime the pump. For that purpose, Congress was asked to appropriate $3,300,000,000 and, fully sold on the theory that this would prime the pump, Congress appropriated the money. The country looked forward to this expenditure as a great effort toward recovery, and the nation as a whole, including the construction industry, was eager for the experiment. This construction program financed with federal money was the hope of the industry, and the one thing that held the industry together.

You will remember the turmoil of the time—the repeated promises made and withdrawn about putting this program into effect, the appointment of a Public Works Administrator, and the tremendous wage scale of $1.20 per hour he forced on construction throughout the nation. That one order, emanating from so high a source, endorsing high wages in the big cities, and in many instances doubling prevailing wages in the smaller cities, swept all private construction out of the picture for the year 1933 and 1934. By so doing, it wrought a devastating blow to both labor and business. Investment in bricks and mortar, steel and concrete, could hardly be expected to bring a return on that wage scale.

There followed the almost entire cessation of private work and finally the PWA program, which was so slow in coming and so encumbered with red tape, that instead of producing a mouthful for the construction industry, it produced only a bitter taste. Because of the exceeding slowness and caution, and due to the ignorance of construction methods and procedure, the program broke down as far as any substantial lift to economic recovery was concerned. It broke down so far that the administration listened to the siren song of the social welfare worker, and took $834,000,000 out of what should have been public works construction and devoted it to raking leaves under the famous CWA.

More priming for the pump

In the meantime, economists agreed that what was needed for economic recovery in the nation was a revival of the durable goods industries, and this again caught the public attention. Inasmuch as construction is admittedly 75 per cent of the durable goods industry, it was merely another way of saying that construction had to be revived before the nation could once more resume an even keel economically. Then fol-

lowed the joint resolution of 1935, appropriating $4,880,000,000 as a bigger bucketful with which to prime the pump.

Let us see what has become of this money. Before the President's signature was dry on the act, Harry Hopkins had secured $580,000,000 for another leaf-raking. In the accounting for the money as made by the U. S. Treasury on Dec. 31, 1935, this $580,000,000 is not mentioned, the accounting being for $4,300,000,000. Of this sum certain commendable allocations were made to be expended through the existing governmental public works agencies which were accustomed to expending money, and which were accustomed to getting full measure of return for such money, because these agencies expended that money through the regularly organized business channels set up for that purpose.

Road money well spent

That statement is true of the sum of $500,000,000 turned over to the Bureau of Public Roads, all of which has been or will be spent by the contract system. It was also true of the bulk of the $82,000,000 turned over to the Reclamation Service, and it was true of the 65 per cent of the $130,000,000 turned over to the Department of War to be expended with efficiency under the Engineering Corps. To PWA was given $446,000,000. Let us here pause to say that Mr. Ickes has learned a lot about construction since his first public-works appropriation; that he is thoroughly sold on the contract system of doing work, and that he has learned, and all his investigations have revealed, that the construction industry as a whole is to be trusted. Mr. Ickes may be counted on to spend this $446,000,000 largely by the contract system.

Then $514,000,000 has gone to CCC; the Resettlement Administration was allotted $181,000,000; WPA was allotted $1,162,000,000; Federal Emergency Relief Administration $935,000,000; not allocated $55,000,000. An administrative cost of $200,000,000, and other comparatively small items account for the total of $4,300,000,000.

It is interesting to know that up to the last Treasury figures available Dec. 31, 1935, the obligations from this sum were $2,340,000,000; the payments out of this sum were $1,672,000,000; the money allotted but not obligated was $1,900,000,000, and the money unexpended was $2,627,000,000. A further study of the figures will show a total of $1,012,000,000 by contract, and $2,921,000,000 by day labor.

Of the $2,900,000,000 to be expended by day labor, all may be said to be highly inefficient, and not 20 per cent of this day labor will actually be converted into tangible wealth. The Code Authority for General Contractors, and the Executive Committee of the A.G.C. anticipated what might happen, and after an appeal to the administration produced no results, went to Congress with a resolution, which had the approval of both contractors' organizations, and of the Construction League of the United States. Verbatim from the resolution is Section 8 of the joint resolution of Congress appropriating the $4,880,000,000. This says: "Wherever practicable in the carrying out of the provisions of this joint resolution, full advantage shall be taken of the facilities of private enterprise." But in the expenditure of the money, Section 8 of the act has been totally disregarded.

How little the construction industry is actually getting out of this program is shown by a recent news release which shows 2,500,000 men on day labor projects, and 10 per cent of that number on contract work.

Having analyzed the disposition of the funds, let us analyze the methods of disposition. Roughly $1,000,000,000 has been allotted to the contract system, of which less than $300,000,000 will be spent on building construction. With those allotments made through the regular channels through which the government has previously been purchasing construction, we have no criticism to make. The great reclamation projects and public works program have proceeded as expeditiously as could be anticipated. The engineering corps was set to go, and did go. But with the $446,000,000 allotted to PWA, if judged by results, the standard has been one of delay.

Eleven months after the passage of the act, only $28,000,000 of the $446,000,000, or less than 6 per cent of the funds made available, have found their way into pay envelopes. A ridiculous burst of contract awards between Nov. 20 and Dec. 15 followed in an effort to make a showing by Dec. 31. But even now, only $126,000,000 out of the $446,000,000, or less than 30 per cent, has been contracted.

Compulsory inefficiency

Let us study the WPA system as differentiated from the PWA system. Out of the fertile brain of Harry Hopkins came that master calculation that $4,880,000,000 divided by 3,500,000 employables equaled $1,400, and that this $1,400 had to be the allotment per man year for labor and materials. Since men are to work 130 hours per month, or 1,560 hours per year, the answer is $.90 per hour for labor and material, and that $.90 has become the "God" of the WPA. To men who knew construction, these figures looked so ridiculous that it was hard to believe that men high in our government could arrive at such a conclusion. The answer has been compulsory inefficiency.

The results of this program in operation have been as follows:

1. A complete breakdown in morale of the workers in the industry, which will only be revealed when we go forward and attempt again to function normally.

2. A year ago, the country accepted without question the assurance of the President that lower rates of pay would apply on relief work, that relief work would not be made attractive. That statement was given wide publicity. Not so wide has been the publicity concerning the retraction of that statement. After heavy pressure from an organized minority, the American Federation of Labor, the original wage scale structure was abandoned, and in our larger cities, the relief-scale has been raised to $90 per month.

3. The relief-scale has been made so attractive that relief workers are refusing to take jobs in private industry when opportunities are offered.

Our present problem

What to do about all this is the general problem of our industry. As a first step, the industry must rid itself of the stigma of what is going on under the name of construction. We must deny responsibility for, or association with, the part of the public works program not being put through the regularly organized channels by the contract system, and we must deny this responsibility in no uncertain terms. If we do not do so, the industry will bear the burden of that public stigma for years to come, and will suffer correspondingly.

I do not wish to conclude this more or less pessimistic study of construction under the new deal without putting into it some optimism. All of us realize that there has been a tremendous backlash in construction. It has been estimated that commercial and industrial construction is $26,000,000,000 in arrears in its logical expansion program. In addition to depreciation, obsolescence has been an increasing factor in creating that demand.

At present, there is more to be done in construction work than has been done in all history. For four years the industry has been lying back, waiting for the government to do something. It has been amply demonstrated that the government is not capable of doing anything to restore construction to anything more than 30 per cent of normal.

It is up to the industry itself to adopt and carry out a program that will produce construction. Such a program would have to consist of the following measures.

(1) The industry must unsell itself on the theory that the government can help it.

(2) The industry must go ahead on the premise that it must create its own demand in construction, and use such work as is produced by the government only to supplement private work.

Bypasses Box the Compass

At Springfield, Mo., four trans-country highways that cross in the center of the city now avoid intersections and congestion by a rectangle of bypasses on the city outskirts

By Walter O. Hill
Assistant Engineer in Charge of Construction, Missouri Highway Department, Springfield, Mo.

SPRINGFIELD, MO., is unusual among small cities in being the meeting point of four trans-country main highways. As marked on the map they are: U. S. 60, Norfolk, Va. to Los Angeles; U. S. 65, St. Paul to Natchez; U. S. 66, Chicago to Los Angeles and U. S. 160, Springfield, Mo. to Monticello, Utah. Some indication of the traffic on these roads is given by the traffic map, Fig. 2. The need of relief from delay and congestion of traffic in the city streets became clear as early as 1925 and that year a plan proposed by the Missouri State Highway Commission for a three-route bypass system around Springfield was adopted by the City Planning Commission, Chamber of Commerce, and the City Commissioners in September.

FIG. 1—LATEST CONCRETE PAVEMENT on the west bypass at Springfield, Mo., has lip curbs, air-cushion transverse joints, bright metal marker joints at center, and is laid on tar paper insulation over the sub-grade.

The purpose of the new system was: (1) To relieve the traffic congestion on the main streets caused by concentrating it to one focal point in the heart of the business district; (2) To increase safety by eliminating five railroad grade crossings; (3) To lessen the confusion which the stranger usually experiences in a strange city; (4) To provide adequate means for the distribution and movement of rural and urban traffic to and from the city, and (5) To save the city the unnecessary expense of maintaining streets for heavy traffic.

Construction gradual but steady

The construction of this bypass system was started in April, 1927, and has progressed steadily since that time. The first unit, the east bypass which handles the through north and south traffic on U. S. Route 65, was completed in December, 1932. Fig. 3 shows this bypass along the eastern city limits; it consists of 4 mi. of 20-ft. concrete pavement, with a wye intersection for U. S. Routes 65 and 66 at the north end, an underpass under the St. Louis & San Francisco R.R. ¾ mi. south, and a wye intersection for U. S. Routes 60 and 65 at the south end.

The second unit, the north bypass extends west from U. S. Route 65 along the northern city limits to U. S. Route 160, State Routes 13 and 123, and the west bypass. This unit consists of 5 mi. of 20-ft. concrete pavement with a wye intersection for State Route 13. It was started in June, 1931, and was completed in December, 1932. U. S. Route 160 traverses the western 2½ mi. of this bypass before it enters the city.

The third unit, the south bypass which handles the through east and west traffic on U. S. Route 60 consists of 6¾ mi. of pavement, special street intersections, an overhead structure over the Missouri Pacific R. R., a concrete bridge over Wilson Creek, and a wye intersection for U. S. Route 60 and City Route 66. This unit was completed in July, 1934. Incorporated into this bypass was about 1 mi. of 18-ft. concrete pavement, built in 1929, and about 1 mi. of 16-ft. asphaltic concrete with 1-ft. concrete protection curbs on each side which was built in 1925. The south bypass extends west from U. S. Route 65 along the southern city limits to State Route 123 and Greene County Route YY, thence north to City Route 66 and thence west to the west bypass.

The fourth unit, or the final connecting link of the bypass system—the west bypass, was finally located after five surveys had been made between 1931 and 1934. The final location chosen was the one nearest the city and the shortest connection between the north and the south bypasses. This location was on a land section line and consequently involved the least right of way damage. The most recent construction work has been on the west bypass, which was completed and opened to traffic in March, 1936, and it is this construction that is described particularly, except as noted.

This west bypass handles the through northeast and southwest traffic on U. S. Route 66. This highway, familiarly called "The Main Street of America" crosses Missouri in a southwesterly direction in a distance of 306 mi. It follows rather closely the St. Louis and San Francisco railroad but the highway distance is 20 mi. shorter. U. S. Route 66 is a heavily traveled commercial route and also carries a larger per cent of through foreign traffic than any other U. S. highway in Missouri. The 12-hr. traffic count taken in August, 1934, showed that this highway west of Springfield carried a total of 3,289 vehicles per day which were composed of 2,469 passenger cars, 742 trucks, and 78 buses. The chief function of the north and the west bypasses is to segregate and route this through traffic around Springfield.

Simple durable bridges were built

Structures on the bypass system vary little in design. The four railroad overhead grade separations have concrete gravity-type abutments on solid rock foundations. The superstructures consist of 14-ft. track slabs encasing nine 24½-in. 130 lb. I-beams (14 in flange) and two 4-ft. reinforced concrete side slabs. All underpasses provide a 30 ft. roadway with an 18-ft. overhead clear-

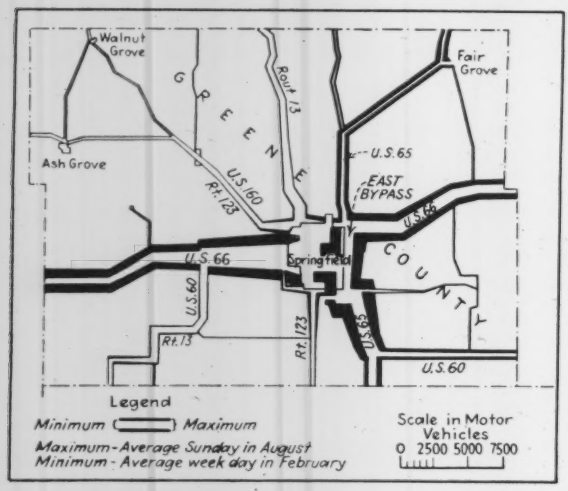


FIG. 2—TRAFFIC centering on Springfield, Mo., as counted by a 24-hour traffic survey made on a Sunday in August and on a weekday in February, 1934.

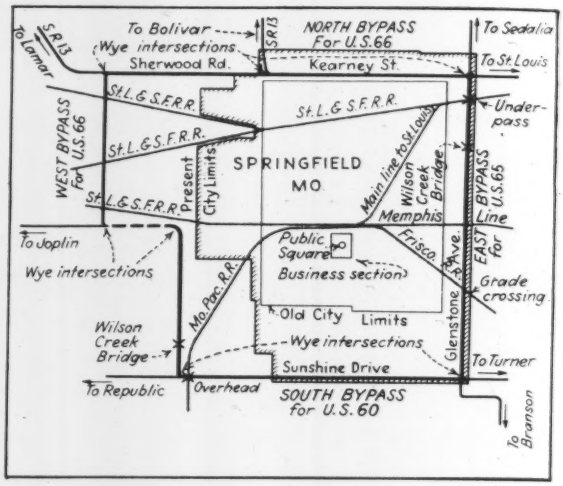


FIG. 3—RECTANGULAR bypass road system around Springfield, Mo., takes the traffic of four cross-country main roads that formerly ran directly into the center of the city.

ance, Fig. 4. The one highway overhead railroad grade separation has concrete open type abutments and intermediate bents placed upon solid rock foundations. The superstructure consists of three 50-ft. concrete deck girder spans with a 30-ft. roadway and 5-ft. sidewalks on each side. The vertical clearance over the railroad is 23 ft., Fig. 4. The bridge over Wilson Creek consists of four 35-ft. concrete deck girder spans upon concrete open type bents on solid rock foundations.

Concreting rigidly controlled

In all structures of the west bypass the proportioning of concrete was by weight and all concrete was vibrated as placed. In cold weather all concrete aggregates and the mixing water were heated by steam from a 30-hp. upright boiler to a temperature of at least 80 deg. F. In addition, all concrete was heated while mixing by a flame torch heater so that the concrete when placed in the forms had a temperature of at least 65 deg. F. All forms were completely housed in by tarpaulins hung on staging and the temperature within the inclosure was maintained between 65 and 75 deg. F. until the concrete had acquired its full design strength.

Three concrete test beams and three concrete test cylinders were made for each pouring. The test beams were broken in the field and the strength of the concrete was determined before the heating was released. Beam breaks showed an average strength in flexure of 713 lb. in four days and cylinders crushed at the laboratory showed an average comprehensive strength of 4,384 lb. per sq.in. in eleven days.

On underpass structures after the forms had been removed Hauck oil burners were placed inside the housing to dry the outside surfaces of the concrete for waterproofing operations. The

TABULATION OF COSTS OF BYPASS ROAD SYSTEM FOR SPRINGFIELD, MO., WITH ESTIMATE OF COSTS OF PLANNED IMPROVEMENTS.

Bypasses completed

	Cost	Miles
Bypass road built by contract	$765,228	16.885
Refund to Springfield Road District for salvage	77,877	1.0
Landscaping	1,591	.....
Damages for right of way	16,801	.....
Total cost of improvement	867,497	17.885

Proposed Improvements

	Cost	Date of Work
Widening to 40 ft., Route 65 to 13	$19,000	1937
Widening to 30 ft., Route 13 to bypass	48,000	1939
Widening to 40 ft., Route 66 to Nat'l. cemetery	170,000	1940
Widening to 40 ft., Route 66	82,000	1938
Highway grade separation	80,000	1942
Railway grade separation	70,000	1943
Right of way damages	20,000	....
Pedestrian underpass	9,000	1936
Total planned work	$498,000	....
Grand total	$1,359,497	....

entire back faces of the abutments were damp-proofed with a bituminous priming coat and a hot asphalt damp-proof coat. The top surface of the bridge floor was waterproofed with an asphalt primer, three layers of cotton fabric laid in hot asphalt and a protective covering of 1 x 8-in. x 4-ft. asphalt planks embedded in and covered with hot asphalt. A continuous strip of sheet lead flashing which had been previously embedded in the concrete curb and left extending out 3 in. was bent down over the asphalt plank along the sides to complete the waterproofing.

Modern paving standards followed

Concrete pavement was of 9:7:9-in section with 3-in. lip curbs reinforced with wire fabric; the weight of one 17⅓ x 10-ft. wire fabric mat was about 71.4 lb. The entire subgrade was insulated from the concrete pavement by tar paper placed longitudinally on the subgrade just prior to placing the concrete. Transverse expansion and contraction joints, which were alternated every 50 ft., were metal air-joints with transload base and copper seal cap. A permanent marker seal (Fig. 1) of galvanized base metal was installed for the longitudinal center joint.

The concrete adjacent to expansion and contraction joints and also that along the side forms was compacted by a vibrator to eliminate honeycombing. Superelevated curves were finished to plane surface by a finishing machine with the crown taken out of the front screed. The surface of the slab was given a broom finish.

Heated mixing water and a calcium chloride solution were incorporated in the concrete mixture, and a flame torch heater was used on the paver for all concrete placed when the atmospheric temperature was below 40 deg. F. The slab was cured under burlap on which 6 in. of straw was placed as a protection from freezing.

Directional signs have been placed at all route intersections indicating the bypasses for fast through traffic and the optional city routes for slow local traffic. Through routes are marked with markers on black and white U. S. shields and city routes are indicated with markers on black and yellow U. S. shields for the convenience of tourists who desire to visit the city.

Future widening planned

The entire bypass system forms a concrete boundary set within an 80-ft. right of way completely surrounding the city. The total mileage is 17.885 miles and the total cost to date is $861,496.98. (See table.) Because of the value already demonstrated by this distinctive and modern bypass system and its efficiency in solving the traffic distribution problem at Springfield, the Missouri State Highway Commission in their Ten Year Tentative Program of June, 1935, has proposed to expend

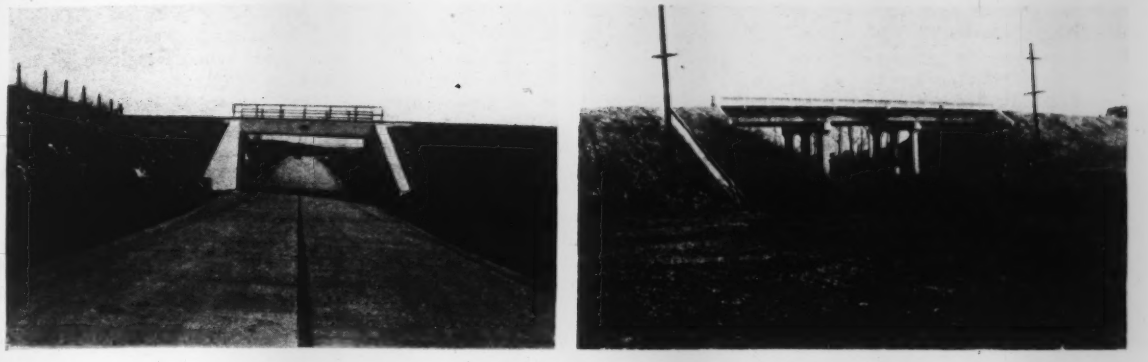


FIG. 4—ROAD AND RAIL grade separations on the bypass system are of simple neat design and of sturdy steel and concrete construction; these views show a road underpass at the left and a road overpass at the right.

about another $500,000 on future improvements. The recommendations include the widening of the concrete pavement to 40 ft., constructing pedestrian underpasses for schools, constructing a highway grade separation (cloverleaf) for U. S. Routes 65 and 66 and constructing a railroad grade separation (highway overhead) on U. S. Route 65 over the St. Louis & San Francisco R. R.

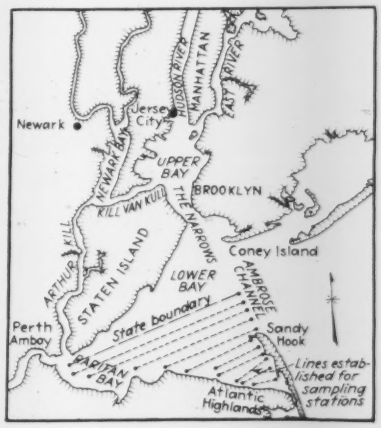
The work on this bypass system was done under the direction of T. H. Cutler, Chief Engineer; D. B. Levi, Engineer of Construction; R. M. Whitton, Division Engineer; and W. O. Hill, Assistant Division Engineer in charge of Construction.

Surveying Sewage Pollution In Shell Fish Producing Waters

Physical and bacteriological studies made by the U. S. Public Health Service to determine areas in Raritan Bay that would be suitable for clam harvesting

INCREASING sewage pollution in the waters of New York harbor in the areas occupied by Raritan Bay, Sandy Hook Bay and the Lower Bay where the harvesting of both hard and soft clams is an important industry, led to action by the New York State health authorities in 1925 and the New Jersey Board of Health in 1934 which greatly restricted the taking of shell fish from a large part of these areas. When New York City further prohibited the sale in that city of clams taken from Raritan Bay, a severe setback was presented to the shell fish industry in this neighborhood. The desirability of a survey of pollution was suggested in 1935 and it was agreed by the interested groups that the sale of clams would be permitted from those areas found suitable by the U. S. Public Health Service.

In a paper presented at the annual meeting of the New Jersey Sewage Works Association at Trenton, N. J., Arthur P. Miller, sanitary engineer in charge of the Interstate Sanitary District No. 1 of the U. S. Public Health Service, described the manner in which this survey was conducted. The following extracts have been taken from this paper:



RARITAN BAY in relation to other parts of the New York metropolitan district and the area in which sampling lines were established

Undertaking the inspection involved a study of actual and potential sources of contamination, the results of which were summarized in a quantitative manner and considered in relation to dilution, tide, currents and time intervals. This study necessarily included the collection of both physical and bacteriological data.

Quantities of sewage discharged

The quantity of sewage contributed to Raritan Bay, either directly or by way of tributary streams, is 1,257.5 m.g.d.; of this amount 959.3 m.g.d. is untreated, 184.5 m.g.d. receives partial treatment and 103.7 m.g.d. is completely treated. The greatest volume of raw sewage finding its way into the bay through contributory streams comes from New York State and is approximately 858 m.g.d. This seems to be a tremendous volume but when it is compared with the entire flow of water through this section, it is not so imposing. Previous investigation has shown that the discharge at the Narrows averages 101,250 m.g.d. and therefore the flow of sewage at this point is about 0.84 per cent of the diluting water. In other terms, there are 119 gallons of diluting water for each gallon of sewage.

There are approximately 55 and 25 m.g.d. of sewage coming from the Arthur Kill (plus Newark Bay) and the Raritan River, respectively. Although precise figures on the flow of water in these two tributaries are not available, both of them are relatively large with 25 ft. to 40 ft. channels and unquestionably have sufficient quantities of water issuing from them to give a dilution factor higher than for the Narrows.

Summing up the question of raw sewage contributions, it appears evident that fairly adequate dilution is available for those wastes not directly deposited in Raritan Bay. Although this bay oc-

cupies an unfortunate position for shell fish cultivation on account of the metropolitan character of the surrounding territory, the great volume of water in it seems to afford fair protection to certain selected areas.

Harbor channels and tidal currents are the two principal forces controlling the pollutional wastes and working to keep them out of New Jersey waters. The Upper Harbor flows carrying the bulk of New York City sewage tend to move out to sea through Ambrose Channel while those from Arthur Kill follow a channel running on the outside of the bay toward Sandy Hook.

Depending upon the direction of the tide, the sewage coming through the Narrows either flows out to sea with only its edges intermingling with clean water or is pushed back toward the New York shore to such an extent that it flows westward over Raritan Bay and up Arthur Kill. Probably more than anything else, these tidal currents help to restrict the New York waste to New York waters, thereby protecting the waters of the New Jersey portion of Raritan Bay.

After an examination of the natural or physical factors, a pollution survey of this kind requires confirmatory evidence obtainable through bacteriological examinations of water samples from the area under inspection. Lines of sampling stations between fixed shore points are most desirable but in a body of water such as this, such lines cannot always be had. Therefore, it was necessary on the five outer lines which vary in length from 7½ to 13½ miles, to run by compass and watch, using a boat, the speed of which had been calibrated in advance. Six other lines of sampling points were established from objects on shore which could be sighted from a moving boat. In addition there were a few odd stations identified by objects in the water. Altogether 118 sampling stations were selected and all of them were used.

Sampling equipment was very simple consisting only of sterile 10 cc. tubes plugged with cotton and a short stick on the bottom of which was a spring device to hold the tubes in position when forced into the water. The boat's speed, the watch and the chart of stations were checked constantly by one man who was responsible for the sampling. A pilot operated the boat and the third man took the samples when so ordered. Only top water samples were taken.

From May 20 to June 22, 1935, when this work was done, five complete runs were made in the entire series of stations. Starting times were calculated each day to insure in the end five samples at each station for the following tidal conditions: (1) high tide, (2) low tide, (3) half flood tide, (4) half ebb tide, (5) three-quarter ebb tide. By following this scheme rather than just taking samples at times most convenient to the workers, the results obtained were exactly comparable.

A laboratory was established by the New Jersey State Department of Health at Highlands, N. J., and all samples were examined the same day they were collected by personnel of that department. Standard methods of water analysis were followed for the determination of B. coli. The general procedure of planting five tubes of each dilution for each sample as is sometimes done in surveys of this kind, entails too much work for a field laboratory. Hence, in the main, 10 cc., 1 cc. and 0.1 cc. amounts were planted for each sample. As the interpretations were to be drawn on the basis of 1 cc. tube results, using those of the 10 cc. and the 0.1 cc. tubes as guides, this method was satisfactory.

Interpretation and results of study

As a result of considerable experimental and field work, the Public Health Service has arrived at the conclusion that generally not more than 50 per cent of the 1 cc. tubes in an area should show the presence of B. coli if that area is to be used for the taking of shell fish for market purposes. This is not an inflexible figure and can be used only as a guide when weighing all the evidence collected.

The presence of B. coli was found to be high in the far western end of the bay and in that portion to the north and northwest of Sandy Hook Point. Except for isloated cases, the bacteriological results in the remainder of the Bay were found quite satisfactory. On this basis these areas were looked upon with suspicion and when considered in the light of the quantities of sewage coming into the waters at the mouth of Arthur Kill and through the Narrows in addition to the movement of the tidal currents back and forth across the mouth of the Narrows and the prevailing northwest winds, it was concluded to urge the closing of an additional area adjacent to Sandy Hook Point.

After proper action by the New Jersey authorities, the areas found unsuitable were officially closed whereupon the New York City Board of Health opened the city's markets to products coming from approved sources.

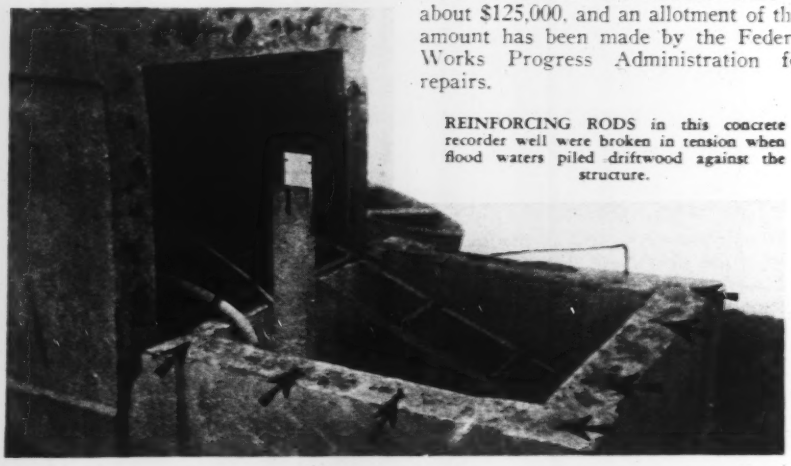
River Gauging Stations Damaged

DAMAGE to river measurement stations of the U. S. Geological Survey resulting from erosion and undermining of banks occurred during the recent floods in the eastern states. Among the water stage installations that were destroyed was the recorder well and house on the Potomac river at Hancock, Md., which was located about 15 ft. shoreward from the low water line, on the left bank of the river. The installation was protected from flood-drift by a number of large trees three or more feet in diameter; the site was chosen because of this protection. The flood of March 1936 exceeded previously recorded floods by about 8 ft., and the trees that were considered as protection to the structure were tipped over by the drift. This exposed the gage house and well to the heavy drift which the river was carrying, and the structure was shoved over about two hours before the crest of the flood. As indicated by the arrows in accompanying picture, the ½-in. steel reinforcing rods were broken in tension.

The trees must have been of considerable size at the time of the 1889 flood, which they survived, and were therefore considered ample protection against drift during a flood of equal height.

This failure indicates that trees as a protection against drift cannot be relied upon, and, as a result, heavier reinforcement will be considered in the design of future structures.

The U. S. Geological Survey has estimated the damage to river measurement stations in the flooded areas at about $125,000, and an allotment of that amount has been made by the Federal Works Progress Administration for repairs.



REINFORCING RODS in this concrete recorder well were broken in tension when flood waters piled driftwood against the structure.

REGULATING TRANSPORT—V

Offland Transport Dodges Reformers

By John S. Worley
Professor of Transportation Engineering University of Michigan, Ann Arbor, Mich.

AIR AND WATER transport have generally escaped impulsive regulation. They have, except in spots been too small to tempt aggressive legislation and again, as navigation, they have come to be regarded wards of federal departments. So in air lines and waterways consideration turns more to development than to regulation.

Water transport small

1. Excepting on the Great Lakes inland waterway transportation is of minor significance.

Governmental control is lodged in a number of organizations. The relations of seamen to masters or owners of vessels, the regulation of radio communication on merchant vessels and other matters of a marine police nature destined to promote good order and safety is under the jurisdiction of the Department of Commerce. The control and licensing of engineers and pilots on steam vessels, the handling of certain dangerous and inflammable cargoes is is looked after by the Steamboat Inspection Service formerly of the Treasury Department but just now under the Department of Commerce. In 1932 the two above services were combined into a single unit.

The Shipping Board has nominal authority over interstate water rates which includes common carriers on the high seas or the Great Lakes operating on regular routes between U. S. ports but does not have jurisdiction over carriers on inland rivers. To all practical purposes none of the states exercises regulatory control over inland water transportation. Various cities do have a certain amount of control in policing wharves, docks and other structures located in ports.

Freight traffic on the Great Lakes can be grouped into four general headings. These headings, with their relative amounts, are as follows:

Class	Percent
Iron Ore	58
Soft and hard coal	24
Grain	8
Stone	9
Misc.	1
Total	100

These amounts, of course, will vary in some degree but the figures show the approximate relationship. The maximum amount of freight was 140,000,000 tons in 1929 and the minimum 42,000,000 tons in 1932. The average cost is about 1 mill per ton mile, although ore and coal in large bulk are transported at a rate slightly less than this. The normal rate for wheat is considered 3c. a bushel, which, on the average haul, makes 1 mill per ton mile. Attention is called to the fact that this 1 mill per ton mile is one-tenth of the average freight rate on railways.

A large part of this navigation is over natural water where no governmental expenditures have been made. The expenditures of any consequence are the improvements at the Sault, the dredging of the St. Clair River, Lake St. Clair, the Detroit River and the construction of the Welland canal, the expense of the latter being borne entirely by the Canadian government. There has also been a small amount of dredging in the principal harbors. The terminal facilities in the way of wharves and docks, warehouses and elevators, as a rule, have been constructed by private industry and the expense of maintenance is borne by private industry.

Such capital expenditures and annual costs of operations as the government may have incurred for the works at the Sault, and for certain dredging operations in the St. Clair River, Lake St. Clair and the Detroit River, and at the principal terminals, appear to be well justified and should these improvements be looked upon as a subsidy of this particular branch of the transportation industry, the subsidy has not been used as a means of increasing the profit to the operators.

The benefits of the low cost of transportation on the Great Lakes, which the public is receiving are not obtained through regulation. In the operation of these Great Lakes transportation companies, the government has not only refrained from attempting to state the rates to be charged but has also refrained from promulgating regulations having to do with the operation of the property. On several occasions it has been necessary for the government to exercise its right of control, with reference to safety matters. Companies and individuals have been left free to enter into Great Lakes transportation and to operate the properties free of regulation excepting that little amount which is found to be in the public interest and have furnished a service at a price about which no complaint is or can be found. This is an outstanding example that low rates and good service is not dependent upon governmental regulation, and particularly that which has managerial aspects.

St. Lawrence waterways ample

2. Great Lakes outlet to the Atlantic is not now inadequate for promised business.

For more than a century the improvement of the St. Lawrence River has been considered by both Canada and the United States. At an early date it was found necessary to construct canals around the rapids of the St. Lawrence to facilitate river navigation; these waterways were later improved until works were provided for all vessels with a draft of 14 ft. or less. As far as any evidence we have been able to produce shows, these works have reasonably supplied all the needs of this particular service.

During the last three decades there has been agitation for the improvement of the St. Lawrence to permit ocean vessels with a draft of 25 to 27 ft. to enter the Great Lakes. Early in the considerations there became coupled with navigation a power project with a potential capacity of 5,000,000 kilowatts. Estimates of construction of the St. Lawrence-Great Lakes improvement by the Joint Board of Engineers of the two countries was placed at $536,000,000. This estimate did not include the full cost for the reason that there was not included the interest on the monies invested during the period of construction. It has been alleged by some of those who are in opposition to the project that the total cost will run well above $1,000,000,000.

While much has been written both for and against this project, at no time has there ever been shown any economic justification. A careful study of all the reports of the engineers of both countries shows that these have always been confined to the engineering features and at no time have contained any statements which could support a belief that there was an economic justification for construction. Some of the work which is necessary for the efficient operation of vessels with 27 ft. draft has been completed. This is largely true with reference to dredging in the Detroit and St. Clair rivers and Lake St. Clair. The Canadian government has also made some permanent improvements meeting the specifications for the lower St. Lawrence. It is possible, because such a proportion of the permanent improvement has now been

finished and since the United States is under some treaty obligations to Canada, that the project should be completed. However, this in no wise changes the fact that the justification of the project, standing upon its own merits, has always been of a questionable character.

Inland waterways uneconomical

3. American inland waterways never economically justified by factual evidence.

The inland waterways of the United States may be considered as being in three groups—Atlantic Coast, Mississippi Valley, and Pacific Coast. The Atlantic Coastal Waterway extends from Boston along the Atlantic coast to Brownsville, Tex. This consists of a channel partially back of the outlying islands and reefs; an inland canal to be built across the state of New Jersey; the Chesapeake & Delaware canal between the Delaware river and Chesapeake Bay; an inland canal through the Dismal Swamp and an inland canal across the state of Florida. The theory of its construction is that it will permit barges and vessels of light construction, of not sufficient strength to be able to navigate in open water, to pass along the Atlantic coast, through stretches of water protected from ocean storms. A part of the theory, of course, is low cost transportation.

This project has a number of ardent advocates who have vigorously promoted it but no time has there ever been an estimate of its complete cost or an estimate of the amount of transportation which could reasonably be expected to be moved or an estimate of the annual cost of operation including the annual capital cost, maintenance and other charges, necessary to form a sound judgment on the merits of the project. Neither has there been shown justification of any kind for the construction of any such a project. In light of these facts it is extremely difficult to understand the authorization of large expenditures of money on disconnected parts of the project by Congress and the recent act of the President of the United States in starting construction work on the canal across Florida.

The Mississippi Valley system consists of the improvement of the Mississippi river from its mouth to St. Paul, the Ohio River to Pittsburgh, the Monongahela and Allegheny rivers for short distances above Pittsburgh, the Illinois River to Lockport, Ill. and the use of the Chicago Drainage Canal from Lockport to Lake Michigan, and the Missouri River from its mouth to Kansas City and Omaha with the suggestion that it should be further improved towards its source. The depth of water now attained, or proposed to be attained, on the Mississippi River system, excepting the Missouri branch, is 9 ft. The depth of water proposed for the Missouri is 6 ft. The Mississippi River now has a depth of 9 ft. from its mouth to St. Louis, the Ohio River has a 9-ft. depth from Pittsburgh to its mouth. The upper Mississippi and the Illinois are now in process of improvement by dredging and the construction of locks and dams to provide a 9-ft. depth. Certain improvements have been made on the Missouri River and others are being carried out to give this river a depth of 6 ft.

At the time the improvement of the Ohio was proposed, which improvement has now been very largely completed, no study of the justification of such improvement was made and the operation on this river up to this time gives little encouragement that any justification will be found. With reference to economic justification, the same can be said of the improvements on the Mississippi River above St. Louis, on the Missouri River and on the Illinois River, including the Chicago Drainage canal to Lake Michigan. The expenditures on the Mississippi River below St. Louis by which navigation has been improved, have been largely for flood protection. In addition to the above, a few of the rivers in Mississippi and Alabama are navigable for several hundred miles, as also are the Sacramento and Columbia rivers on the Pacific coast. However, these latter are of minor importance.

Minor transport problems

4. Air travel, pipe lines and electric railways present no intricacies of regulation.

The Interstate Commerce Act as amended by the Hepburn Act of 1906 gave to the Interstate Commerce Commission jurisdiction over the interstate transportation of oil and other commodities, except water and natural or artificial gas by pipe line. The jurisdiction of the commission, however, extends only to common carriers in enterprises which are solely of that character; the transportation of proprietary oil even though this transportation is interstate, does not come under the control of the Interstate Commerce Commission.

In certain states the intrastate transportation of oil by common carriers has been subject to regulation by the public utility commissions.

In the exercise of its jurisdiction, the Interstate Commerce Commission has found but little occasion to promulgate rules having to do with the safety elements of operation. Its regulation has constituted primarily control over rates, and seeing that the common carrier pipe line companies observed the principles of uniform treatment of all shippers both in the matter of service and rates. In many instances the charges for transportation by pipe lines have been less than 50 per cent of that which was being charged by the railways.

The transportation of oil by pipe lines is very largely an independent activity, related in no way to other transportation agencies. The regulation has been satisfactory to the public and can be said to have been administered in the public interest.

As has already been said, air transportation is a very insignificant part of our national transportation. In exactly the same manner as all other industries, it has a beginning, a growth and development in accordance with its ability to grow and the demands for its service.

Those who were interested in its development and made investments therein always found themselves under the handicap of the need of additional finances. As a result aid was sought from cities and towns, and other local communities, from the various states and the federal government. The aid obtained from cities and villages was primarily landing fields, of which in some degree the construction, operation and use has been regulated by city ordinances. Many of the states being interested in promoting air transportation have made appropriations for both permanent and temporary landing fields.

In the early stages the operators of air transportation, in addition to local communities in the states, appealed to the federal government for whatever aid they could obtain. The principal part of this aid consisted in air-mail contracts which were indirectly subsidies toward the development of this new industry. In addition the federal government has established and lighted many miles of interstate routes and has installed and operated a number of radio directing stations and systems. In the matter of mail contracts they naturally came under the jurisdiction of the Post-office Department. The establishment of emergency landing fields, the establishment of flying routes, light and radio beacons, the physical characteristics of airships and qualifications of pilots was early assigned to the Department of Commerce.

The ensuing Congress conferred upon the Interstate Commerce Commission, with some restrictions, the power to establish air mail rates and approve air mail contracts. As far as is necessary to carry out this mandate of Congress, the commission has the power to examine into the accounts of the various companies and require of them such accounting and other administrative acts as is necessary for the commission properly to exercise its jurisdiction.

The federal government at no time has exercised any jurisdiction whatever over the construction and operation of electric railways other than those as a part of steam railway properties. In the intrastate transportation many of the states have and do continue to have control over these matters.

The concluding article of this series will be published July 16.

Notes from The Field—

Air and Water in the Southwest

I AM WRITING from the Pacific Coast Southwest; perhaps *extreme* Southwest would be more appropriate. San Diego, its focal point is distinctive due to its location as well as its physical conditions. The city has only one-quarter the tributary area enjoyed by inland towns, the other three-quarters are made up of Mexico and the Pacific Ocean. It lies in the sunniest and dryest region of the Coast.

San Diego approached by air

To such an airminded town the most fitting approach is by way of the comfortable air transports that span the 125 miles from Los Angeles to San Diego in 50 min. The aerial approach gives an attractive birdseye view of beach towns dotting the shore line north of the city. But shore *line* is a misnomer; a line has no width, while the beach is a wide band of yellow sand adjoining another wide zone, glistening white with foam and breakers and shading outward into a light blue that in turn deepens into violet.

San Diego has been airminded ever since Glenn Curtis used North Island for an experimental air field in 1908. Rockwell Field, on this same site, now is one of the navy's major air bases. The visitor is reminded that Lindbergh's "Spirit of St. Louis" was built in a San Diego airplane factory, of which there are now several. The latest to arrive is the Consolidated Aircraft Corp., an enormous plant which recently moved from Buffalo to the excellent municipal airport here. This field could be close in because ample tide-land was available on the edge of the business district of the city.

Exposition reopened

San Diego has been much in the public prints by reason of its exposition. With 5,000,000 paid admissions last year, small wonder the exposition has reopened for another season. Even if the exhibits should not be considered worth a second visit the charm of night illumination in so beautiful a garden would justify it.

In a civic report made in 1912 there is a statement that San Diego's city hall was then so old and inadequate as to require immediate replacement. That was 24 years ago; the city still awaits the new structure. However, now there is prospect of early reward for hope long deferred; a carefully planned civic center on the waterfront is a scene of busy activity, and new municipal structures are being erected.

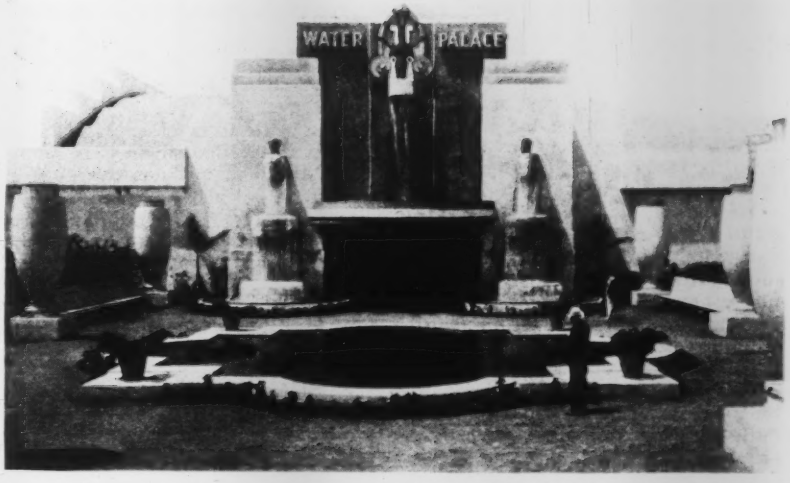


Photo by Metropolitan Water District

ONE OF THE MANY buildings at the San Diego Exposition is the Water Palace

At the county fair grounds north of the city, WPA workers are building an adobe wall—an almost ideal type of work-relief construction. The percentage of hand labor is much the same as when the Franciscan padres built the old mission walls in this territory a century and a half ago. However, this new wall seems to need weatherproofing—has the art of making adobe weatherproof been lost?

An unusual water problem

Most cities have some special engineering problem. In San Diego it is water supply. A really excellent system of reservoirs and conduits provides ample supply for the city's present population of 180,000, but in so arid a region this has been an unusual task. Heavy runoff has recurred rather regularly at 11-year intervals, and so the natural choice is for 11-year storage capacity. But in this climate an 11-year period of storage entails an evaporation loss of one-half the total amount stored!

San Diego needs more water for its future growth, and so with the construction of Boulder Dam the city acquired a right to 155 sec.-ft. of water from the Colorado River. As yet it has not decided how to bring this water in. The Metropolitan Water District of Southern California offers to serve Dan Diego through the Colorado River aqueduct if it will join the district, while the city would prefer to buy water and avoid carrying its share of the capital charges. To join would require the payment of $660,000 (the amount that would have been paid since 1929 had the city joined the district) plus annual water charges ranging up to a maximum of $1,624,000 per annum in 1970.

As against this plan the city could bring its Colorado River water supply part of the way in the All-American Canal, which is to be built for irrigation service as far as the eastern edge of the mountain range separating Imperial Valley from the coast. The city's share in canal construction costs would be $475,000, or about $12,000 per year over a 38-year period. To this would have to be added a share of canal operating costs in proportion to the city's part of the flow. From the end of the canal through or over the mountains to San Diego the city would have to build its own conduits, tunnels and pumps. An engineering board (L. C. Hill, Lester S. Ready and J. P. Buwalda) is now at work comparing these water supply possibilities, and action is expected when this report is made.

Whatever decision is reached, San Diego proposes to provide an abundant supply for future years. Water is the one element that nature did not provide in this immediate locality. In its absence the desert menaces; with abundant water a semi-tropical garden blooms.

—N.A.B.

San Diego, California,
June 14, 1936.

Soil Mechanics Formally Accredited

Continuation of the report of five-day conference held at Cambridge, Mass., June 22-26 by 200 delegates from many nations to discuss new science

THE EXCEPTIONALLY difficult foundation conditions in Mexico City and the large settlements commonly experienced there were ably reviewed by J. A. Cuevas, engineer, of that city. Mr. Cuevas has taken the first steps toward more exact study of settlement phenomena there by establishing a number of survey points carried down to great depths by means of rods, in order to throw light on the vertical distribution of the settlement. He asked for suggestions as to a program for studying and dealing with the settlement problem.

The subsoil of the city is an old lake fill to depths exceeding 3 00 m. and consists mainly of clay that becomes lighter in weight with depth and has high moisture content and large shrinkage. Volcanic windblown dust is believed to be the source of most of the soil. Levels on buildings have been taken for 50 years, and settlements up to 1 m. have been observed on old as well as new buildings. The slope of the Grand Canal was reduced by 2.7 cm. per km., while sewers toward the east of the city gained slope. There is a general subsidence in addition to local settlement under loads, and the pipes of deep wells lift and must be cut off periodically. A geodetic base line has shortened materially.

Foundations in soft soil

Buildings settle during construction, and in the older buildings the lower stories show more sag than the upper, indicating that the settling began early and the builders leveled up as construction proceeded. Settlement is always greatest toward the center of the building. An exceptional case is a pumping station that has settled and lifted alternately though it weighs less than the soil displaced. The ground always rises when a building is torn down, neighboring buildings settle or rise, according to their spacing.

Soft soil and records of long-continued settlement of buildings also characterize the city of Cairo, Egypt. Rock is deeper than any borings yet made. The surface soil is silt, over stiff clay, over soft clay; sand is found usually at 30 to 60 ft. depth. Water is 10 to 17 ft. below ground, but rises 5 ft. in flood-time. In a group of papers W. S. Hanna and G. Tschebotareff, Egyptian University, Cairo, reported that in recent years modern buildings (limited to 12 stories or 150 ft., and largely of reinforced-concrete box type on raft or pile foundations) have settled greatly, though because of their stiffness the trouble was not at once recognized. One of the difficulties found is that the foundation piles usually are too short; cast-in-place piles 25 to 30 ft. long are common, and usually no thought has been given to carrying the piles down to the sand.

The settlements observed correspond well with the Boussinesq distribution of load, and their amounts check the consolidation calculated from permeability measurements. Loads on clay are generally ½ to 1 ton per sq. ft., on sand 3 to 4 tons. Yet practically every type of raft or pile foundation on clay is subject to settlements of 3 to 6 in. and causes damage to adjoining buildings (not from pile driving), while no noticeable settlement occurs in districts where sand is at or near the surface.

A reinforced-concrete water tank tower 40 in. high built in the last two years, on raft foundation, with 0.9 ton per sq. ft. loading, showed ¾ in. settlement within 8 months after filling, and settlement was continuing at the same rate. Yet a soil-loading test on 1 sq. m. area showed only ⅛ in. settlement under a loading of 4 tons per sq. ft.

Road soil problems

Opening the discussion of soil problems in highway engineering, C. A. Hogentogler, Washington, D. C., pointed to the South Carolina experimental work on stabilization by cement and other media and declared that the dream of hardening clay soils for road-surface use has been made a reality. The subsoiling tried in Missouri to stabilize road soils has been similarly successful. Prof. H. F. Winterkorn, Columbia, Mo., stated that gravel road surfaces in Missouri have been successfully stabilized by base exchange through use of calcium chloride, while soil surfaces have been stabilized by a combination of base exchange and bituminous addition, with use of special binders to hold the oil to the soil particles against the disintegrating action of water. Soaps and like materials having binary molecules, organic on one side and inorganic on the other to bond with both soil and bitumen, have proved successful.

Earle F. Bennett, of the Maine highway department, Augusta, reported on different methods used for dealing with muck layers in a marsh under a highway fill. Traffic vibrations in soil and their effect on settlement were discussed by R. Tillmann, Public Works Department, Vienna, Austria, who put the amplitude of such vibrations at 0.005 to 0.030 mm. and the frequency at 5 to 100 cycles per sec. Similar vibrations, he stated, may be set up by machinery such as a concrete mixer. Unequal settlement in a large apartment house during construction was attributed to a mixer and hoist near the point of settlement.

Earth pressure, walls and piers

Earth pressure discussion was opened by Prof. A. Casagrande, who listed the chief contributions to this subject by the preprinted papers submitted to the conference. These cover: the influence of saturation from heavy rain on pressure against retaining walls; proof that uplift in soil, rock and concrete has full hydrostatic value; experimental proof that internal shearing strength of soil is not always fully mobilized, because of hydrostatic pressure; data on pressure on tunnel lining, showing that passive pressure is not fully developed; study of the complex pressures on sheet-pile bulkheads; and proof that water does not affect the internal friction of sands. He asked that all observations on pressures and movements of sheeted cuts be reported.

Discussing the swelling pressure of clay, Dr. Terzaghi presented an analysis of the action that develops as the hydrostatic moisture pressure in the interior of a clay mass is reduced to zero at the surface of a tunnel or shaft opened in the mass. The surface tension of the water at the exposed surface of the clay gives rise to negative pressure within the mass near the surface, and because of the positive hydrostatic pressure farther in the mass there results a flow of water toward the bore, with swelling of the clay. In a trench tunnel 14 m. wide in stiff clay of 56 per cent moisture content the material showed no compression under pressures of 4 tons per sq. ft., but decrease of pressure caused it to absorb water by 35 per cent and produced severe swelling. The contractor therefore decided to excavate 15 per cent excess section. That humidity of the air was not related to the action was shown by exposing specimens of the clay to air of 100 per cent humidity, when the clay absorbed no water. Despite the excess excavation, the tunnel arch (the Belgian or crown method of tunnel construction was used) was forced 8 in. downward into its abutments. The same action was studied by pressure-gage measurements in a drift in swelling clay, which showed a pressure of 2.3 tons per sq. ft. developed between the side walls of a lateral borehole after 20 days.

A new form of retaining-wall test, devised to eliminate end-wall friction, was described by J. E. B. Jennings, Massachusetts Institute of Technology, Cambridge. The wall is short and the

backfill or loading consists of lengths of round steel rods of different sizes, each the length of the wall and lying parallel to it. The observed movements and pressures agree well with those of careful prior tests, he stated.

Prof. Wm. P. Kimball, Hanover, N. H., referred to the rise and fall of the piers of the New Orleans bridge during changing water stages, and reported that the compression of the water in a depth of 2,000 ft. does not fully account for it. Dr. Terzaghi pointed out that (in accordance with the settlement theory given by him earlier, as reported above) the prism of earth under the loaded area (the width of the river) bulges laterally under increased load, which will increase the settlement over that due to vertical, restrained compression alone. D. M. Burmister, New York, reported tests with a soil anchor, which in all cases developed a shear surface at the same angle to the horizontal regardless of pull or vertical load.

Compacting sand soils

In the construction of the new express highway network now being built in Germany it was desirable to place pavement slabs on fills without waiting for them to settle naturally. Extensive experiments were therefore made with different means of compaction of non-cohesive materials. These were described by W. Loss, of Berlin. Mechanical analyses of the fill material, density determinations by direct measurement and by velocity of elastic waves in the soil, and full sets of levels, were auxiliary to the experiments.

The compaction methods included ponding, washing by jets, rolling, tamping by various forms of power tamper, and surface vibration. Ponding and surface jetting were of limited effect, and the jetting produced undesired segregation. Rolling with grooved rollers gave mediocre results. A ram having a 2-ton weight with 1½ to 2 m. fall had good effect on uniform sand, but slight effect on non-uniform sand, and too heavy tamping sometimes had a loosening effect. A gang tamper, having four ½-ton hammers mounted on the front of a crawler tractor, is under trial. The so-called Delmag "Frosch," known in the United States as "Leaping Lena," has given good results; 600 machines of 500 kg. weight are in use, as well as a few of 1,000 kg., and a 2,000 kg. machine is being built.

Surface vibrators

Several surface vibrators are in use, on building sites as well as on road fills. The usual size weighs about 2 tons and comprises a motor with eccentric weights mounted on a heavy base-plate, both speed and eccentricity being adjustable. A 25-ton machine with vibration speed of 25 cycles is being tried. Adjustment of speed is believed important, as every mass of soil appears to have its own resonance frequency. In some tests, subsurface water jetting with surface vibration gave good compaction to depths of 10 to 15 m.

Soil exploration

In opening discussion of soil exploration and sampling H. A. Mohr, Gow Co., Boston, expressed the view that while generally similar methods have been developed in different countries sampling is not yet a fully successful procedure. Bitumen is probably a doubtful aid in holding the soil together during the extraction of the sample. It may not be necessary to get undisturbed samples of granular soils. For plastic soils various specially built spoons give reasonably undisturbed samples. Interpretation of test results is still weak.

Deformation of the sample by the pressure of the tool, either before or during cutting, was held by some to be a source of possible serious error through remolding, while others considered it negligible. Dr. K. Terzaghi, Vienna, claimed it to be more significant than the deformation during preparation of the sample for test. Daniel E. Moran, New York, mentioned particularly the effect of pressure change during extraction of the sample, which may be important where the soil, as often occurs, contains gas. E. W. Vaughn, Tennessee Valley Authority, Knoxville, Tenn., reported that in sampling finely laminated clay and sand strata at Chickamauga dam site with a shell sampler the layers were found to be sharply bent or cupped by the cutting pressure. He also stated that maximum shearing strength was often found at lower water content than maximum density. S. J. Buchanan, Waterways Experiment Station, Vicksburg, Miss., reported having overcome deformation of the sample by slightly recessing the sampler tube inside the cutting edge to eliminate interior friction; such samples produced samples equal in length to the depth driven.

Prof. W. S. Housel, Ann Arbor, Mich., argued for load tests on soil in place made at various depths, as better than laboratory tests on removed samples. He defined the initial shear strength of clay as yield value, and the deformation under added load as measure of plastic flow.

E. F. Bennett, Augusta, Me., reported favorable results from estimating required pile lengths by driving a 1 in. round rod into the ground and recording penetration per blow; the penetration of the rod is greater than that of the pile per unit of driving energy. In cohesive soils a 3-in. soil auger has been used to 68 ft. depth. Generally in Maine, with rock from 20 to 50 ft. down, auger and rod exploration gives sufficient design data in two or three days' work.

Abstracts of some of the papers will be published in subsequent issues.

Tenure Records and Activities of City Managers Analyzed

A SURVEY of the tenure records of 25 per cent of the members of the International City Managers Association who have served their cities ten years or more, reported in the City Managers' News Letter, shows that a number of the 451 active managers now in service have followed the profession for fifteen to eighteen years. The record is considered gratifying, as it has been barely twenty years since the first few cities set up this form of governmental administration, which puts an appointive technician at the head of municipal affairs instead of an elected individual.

The analysis indicates that the city manager and his job vary from city to city. In most small cities—those under 15,000—the manager must assume immediate direction of many administrative functions. He sometimes holds as many as five positions, acting as finance officer, city engineer, waterworks superintendent, electric plant manager and secretary of the planning commission. In the larger cities, especially those over 100,000, the duties of the manager are confined to the broader phases of administration.

While two out of three city managers have attended college, only one was graduated, it was found. Three-fourths of these managers had held governmental positions, generally a public administrative post, for some time prior to becoming city manager, and public service was the predominant occupation for 42 per cent of them before they entered the profession. Over half of them came directly from some public position, one in five from private engineering, and one in four from professions and business.

The average length of service for all managers is slightly under six years. Seventy-three city managers are serving in their second, third, fourth, fifth, sixth or seventh term.

The annual turnover in the profession is about 15 per cent cent, but approximately one-half of the managers who left their positions in the last few years have been appointed to federal, state, county or city positions of an administrative nature.

Bascule Floor Modernized

Silicon steel, aluminum alloy and asphalt plank form a light-weight smooth floor for bascule bridge whose rough plank flooring had long made it a traffic nuisance

MODERNIZATION of the Boston Post Road bascule crossing over the Poquonock River on the line of Stratford Ave., Bridgeport, Conn., by fitting it with a durable light floor of ample load capacity and smooth surface is in active progress. For years the bridge has been a hindrance to traffic and a source of large expense, as its floor was chronically rough and in bad repair, maintenance was costly and traffic was slowed down, which added to the congestion in the approach streets. The new floor, which necessarily is of light weight, is an interesting combination of silicon steel stringers, aluminum channel deck and asphalt plank surfacing. By its construction the load capacity of the bridge is being increased from H15 to H30 live-loading.

The Stratford Ave. bridge was built in 1919 by Holbrook, Cabot & Rollins and the Empire Construction Co. for the city of Bridgeport; J. E. Greiner & Co. were consulting engineers to the city. It is a two-leaf bascule of about 140 ft. clear opening and 56 ft. width. Originally the two leaves were each a single structure over the full width of the roadway, but because of trouble from binding of the moving parts the whole bridge was cut in two lengthwise six or seven years ago, so that each leaf now consists of two independently operated halves, which may be raised or lowered either together or separately. This division is being made use of in the deck reconstruction. The half carrying the westbound roadway was first redecked, while traffic was concentrated on the other roadway; now the eastbound roadway is being modernized, traffic proceeding in two single lanes over what is normally the westbound roadway, and street car traffic is operating over the one track on the completed half by way of crossovers on the approaches.

Design of the new floor was controlled by the necessity of remaining within the weight of the old deck, and yet producing a smooth and durable floor of large load capacity and minimum maintenance cost. The plank deck had for some time before reconstruction been subject to the regulation that trucks were confined to the car track; with the new floor it was important to have no similar limitation on traffic movement.

The old floor weighed about 57 lb. per sq.ft., including I-beam stringers framed between trussed floorbeams, heavy spiking strips bolted to the flanges of the stringers, transverse 4-in. planking, and track ties. In order to get the increased live-load capacity (to H30 loading) in the new floor the redesign was carried down to include the stringer system; this step also made it possible to reduce the slab spans and thereby hold down the slab weight.

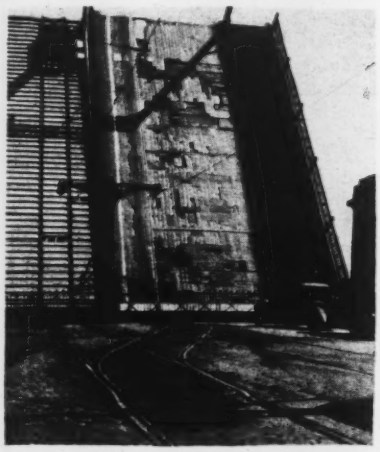


FIG. 1—CHRONICALLY dilipidated plank flooring, frequently patched in vain, made the Stratford Ave. bascule bridge on the Boston Post Road at Bridgeport, Conn., a traffic bottleneck by slowing up all vehicles and making it necessary to limit trucks to the street-car tracks. The old floor, shown on the right (southwest leaf) is being replaced by an asphalt plank floor on aluminum channel slab supported by silicon steel stringers (as shown for the northwest leaf at the left in the view, before the asphalt plank surface was placed on the channel-troughing slab).

Consideration of various forms of modern light decking led to selection of a slab formed of channels laid flat, flanges up, alternating with flanges down—in an arrangement similar to that of the Belmont floor but with flanges butted instead of lapped—and to the decision to use aluminum-alloy channels. These channels are assembled in panels 6 ft. wide (longitudinal of the bridge), and 18 ft. in maximum length (curb to track rail). The panel is composed of channels 8 in. wide, of weights 4.38 lb. per lin.ft. for the trough channel and 4.89 per lin.ft. for the cap channel, whose web carries the pavement surfacing directly. Adjacent panels are separated by a $3\frac{1}{4}$x$\frac{1}{4}$-in. aluminum-alloy bar extending transverse to the roadway and projecting 1 in. above the top of the channels, as a pavement retainer to hold the surfacing against creep, particularly when the draw is opened. The slab is leveled off by filling its troughs with preformed asphalt filter blocks $7\frac{1}{2}$ x $2\frac{1}{2}$ in. x 3 ft. long, bedded in and grouted with melted asphalt mastic (weighing 8.8 lb. per square foot of bridge floor) and then is surfaced with asphalt planks $1\frac{1}{4}$ in. thick, in units 12x24 in. (weighing 10.5 lb. per square foot of bridge floor). Stone chips embedded in the tops of these planks give grip to vehicle tires. The filler blocks and planks are composed of asphalt, fiber and mineral filler combined to conform to A.A.S.H.O. specification M-46, and having a density of about 90 lb. per cu.ft.

The decking is supported on longitudinal stringers spaced 3 ft. 4 in. With a view to weight-saving, silicon steel was decided on for these stringers, and continuity was utilized by making each stringer of a single unspliced length of I-beam from mid-channel to abutment. These stringers rest on the top chords of the trussed floorbeams, to make continuous constructiou possible (the old stringers having been framed between the chords). The rail stringers consist each of two I-beams about 2 ft. apart, connected by riveted cross-bars made of 4-in. H-beams that support the rail.

Steel rivets are being used throughout, for the aluminum alloy panels as well as for the stringers. Aluminum as well as steel is primed with red lead and linseed oil, except that the top of the channel slabs is left unpainted for better adhesion of the asphalt cement that holds the filler and paving blocks in place. All exposed metalwork is painted with gray oil paint after the floor is completed.

The new floor, together with a low curb-guard along both longitudinal edges of the roadway, weighs 89,000 lb. per leaf, stringers included. This represents a unit weight of 46.2 lb. per sq. ft., of which roughly 30 lb. is slab weight and 16 lb. the weight of the stringers and curb-guards. A single panel of deck slab, with a weight of 1,009 lb., was the heaviest erection piece.

The deck reconstruction is being done by Edward E. Bray Co., Bridgeport, as general contractor, and Leake & Nelson, Bridgeport, as erection subcon-

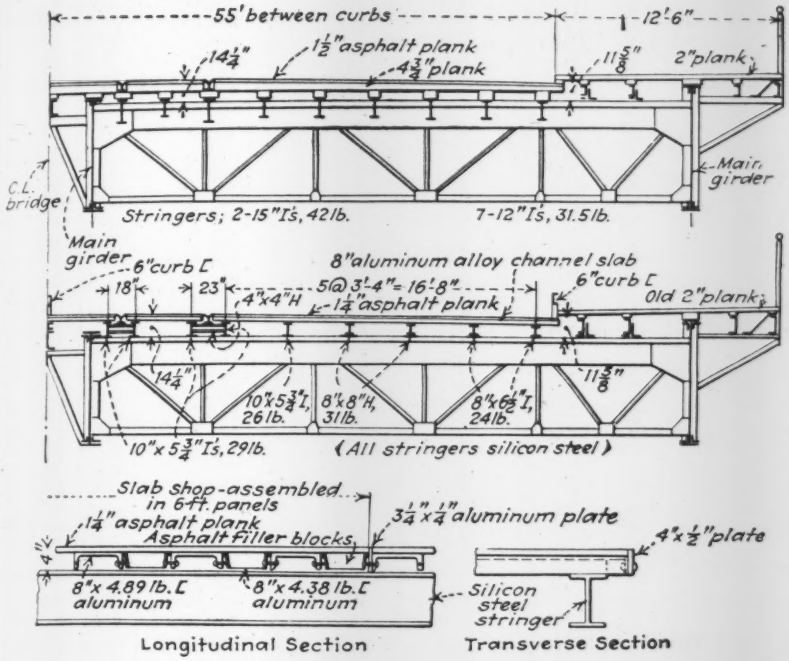


FIG. 2—LIGHTWEIGHT FLOOR designed to replace the old wood plank floor of the Stratford Ave. bascule without increasing the dead load comprises silicon steel continuous stringers 70 ft. long, aluminum channel floor slab with transverse creep strips projecting 2 in. above its top at 6-ft. intervals, molded asphalt filler blocks in the troughs, and 1¼ in. molded asphalt plank with embedded stone-chip surfacing. The weight is slightly less than that of the old stringers and plank.

FIG. 3—AFTER THE TROUGHS of the channel slab are filled with asphalt block fillers grouted in place with melted asphalt, a stone-surfaced asphalt plank wearing surface is cemented on to make the finished roadway. At the curb (left) a longitudinal channel carried between short double-angle posts is intended to function as a kind of wheelguard.

tractor for the state highway department, which is acting as construction agency for the city of Bridgeport. A. B. Done is engineer in charge for the general contractor. For the state highway department of Connecticut the design of the new floor and supervision of construction is in the hands of C. L. Nord, engineer of bridge inspection, under the direction of E. C. Welden, deputy commissioner. The work includes, in addition to the bascule deck, construction of a reinforced-concrete slab deck on the 21-ft. spans over the counterweight pits. After reconstruction the bridge will become part of the state road system.

New Metering Service for Louisville

LAST YEAR 13,000 new meters were added to the system of the Louisville Water Co. bringing 48,600 water consumers or 75 per cent of the total under metered service. John Chambers, chief engineer, reports that the program of installing meters on all services, where rates under the existing schedule justified such change, was completed during the early part of May. The installation of meter vaults was continued through the middle of November. Vaults only were installed on all service connections, with the exception of 6,000 where rates are $7 per year or less. By careful organization and mass scheduling, this work was accomplished economically and expeditiously; vaults for ⅝-in. meters cost $6.66 each.

In connection with a newly installed stub system of accounting and the inauguration of continuous billing, it became necessary to re-route and re-district all metered consumers. This was accomplished with the aid of a set of Sanborn insurance maps. All existing buildings and vacant lots were assigned permanent accounting numbers for identification in the order within each of the twenty-three districts in which the meters in that district would be read. This plan obviates the necessity of re-routing and re-numbering accounts as additional consumers are added in the future. A major portion of the work was the renumbering of 48,000 meter consumers' addressograph plates.

In order to comply with the rules and regulations of the Public Service Commission of Kentucky, and better the handling of meter testing and repair with improved records for the water company's benefit, it became necessary to reorganize and enlarge the meter testing and repair department. This department is able to exchange, test and repair each meter in the entire system at a five-year or less interval. Through a system of cross-indexed file cards the meter testing records and meter test and repair record and the consumers meter record are readily obtainable. It is believed by Mr. Chambers that the shop as now arranged and operating is equal to any other in the country. Full force of the additional meters on consumption was not effective in 1935, although a 5½ per cent reduction below the 1934 consumption is attributed to the added 13,000 meters.

Specifications and Research From the A.S.T.M.

Annual meeting last week in Atlantic City characterized by many specification developments, several notable research papers including one on the Mount Hope Bridge wire, and a radiography symposium

THE ANNUAL meeting of the American Society for Testing Materials, held in Atlantic City, June 29-July 3, produced its usual large complement of materials specifications and new research knowledge. A symposium on radiography and x-ray diffraction methods extending through four of the eighteen meeting sessions dominated the early days of the convention, and a large number of committee recommendations were acted upon, relating to steel, cement, non-ferrous metals, bituminous materials, lime, concrete and paint. Among the items of significant engineering interest that came out of the meeting are a paper on the failure of the cable wire in the Mount Hope suspension bridge, a new definition of portland cement, a new specification for structural nickel steel and a standard specification for high-early-strength cement. Important researches on concrete and bituminous materials were also outlined.

The attendance of 1131 was the largest on record, excepting only the meeting in Chicago during the Century of Progress exposition. The upward climb in membership begun over a year ago has continued at an accelerated pace; the net gain for the year was 129, bringing the total membership to 3741. C. L. Warwick, secretary-treasurer, also reported sales of publications and reprints at $16,000, the largest in the history of the society. Next year, the meeting will be held in New York City.

Inter-society activities

During the year several important manifestations of the Society's cooperative relationship with other organizations occurred. The American Railway Engineering Association appointed representatives to ten A.S.T.M. committees, to improve standardization cooperation. The development of recommended practices for the heat treatment of steels will be aided by the appointment of an A.S.T.M. representative on the handbook committee of the American Society for Metals. And, finally and most important, definite agreement has been reached with the American Concrete Institute on the matter of overlapping specifications and activities. The scope of A.S.T.M., it has been agreed, does not include the field of design and construction, and the A.C.I. will handle all such matters. The A.S.T.M. reinforced concrete committee has been discontinued, and several A.S.T.M. specifications covering concrete curing will be turned over to the A.C.I. A.S.T.M. will continue to sponsor developments of tests and specifications for concrete and its constituent materials.

Among committee developments were recorded the authorization of a committee on soils for engineering purposes. Also, the committee on mortars for unit masonry was disbanded, to permit more efficient reorganization, and the committee on slate has been discontinued and its functions merged with those of the committee on natural building stones. During the convention a conference was held to determine if the committee on testing might be of assistance in correlating present considerations relating to humidity and temperature conditions and their effects on the properties of materials. The object of the meeting was to determine if there is a need for the study and establishment of standard atmospheric test conditions for the various materials under A.S.T.M. specifications. Represented at the conference were members of the committees on cement, concrete, timber, bituminous materials, metals, electrical insulating materials and textiles. Further study of the subject is planned.

New officers

The opening session of the society was featured by an address by H. C. Parmelee, editor, *Engineering & Mining Journal*, on the relationship of A.S.T.M. to modern developments in chemical engineering, and by the introduction of the new officers. New materials are coming out of the chemical laboratories at a greater rate than ever before, and the need for their rapid assimilation by industry through the development of standards and acceptance tests represents a new challenge to the A.S.T.M., said Dr. Parmelee. The remarkable developments in plastics and the potentialities of carbon as a construction material were particularly emphasized.

The new president of the society is A. C. Fieldner, chief engineer, experiment stations division, U. S. Bureau of Mines. T. G. Delbridge, manager, research and development department, Atlantic Refining Co., was elected vice-president. H. S. Vassar of the Public Service Electric & Gas Co., Irvington, N. J., is the retiring president. The Charles B. Dudley medal, awarded for the most meritorious paper at the preceding convention, went to H. C. Mann, senior materials engineer, Ordnance Department, Watertown Arsenal, for his paper on "The Relation between the Tension Static and Dynamic Tests."

Edgar Marburg lecture

A high spot on the program was the annual Edgar Marburg lecture, which was delivered by Arthur L. Day, director, Geophysical Laboratory, Carnegie Institution of Washington. Dr. Day spoke on developing American glass which was climaxed recently by the successful pouring of the 200-in. diameter telescope lens, made of a glass with an expansion coefficient one-third that of window glass. This glass of borosilicate type required a temperature of 1550 deg. C. in its manufacture, which is twice that used for ordinary window glass made from silica with lime and soda as the fluxing agents. If high temperatures could be handled more economically, fireproof glass would be practicable, according to Dr. Day. In his talk he referred to recent developments in the making of stronger glass by oil quenching. Care must be exercised, however, to guard against overquenching, for this sets up internal stresses that may cause the glass to explode. On the other hand, taxicabs in Paris are equipped with one type of overquenched glass as a safety precaution. When struck hard, this glass explodes into small, round particles, with no sharp or cutting edges.

X-ray testing

The special feature sessions of this year's meeting were devoted to a symposium of 12 papers on the use of radiography and x-ray diffraction methods in the examination and testing of materials. Radiography using x-rays or gamma rays from radium is finding increasing application for non-destructive testing in industry, and has been used on many large penstock installations in the past few years. X-ray diffraction methods are just coming into use; their most important field of application is in the identification of materials or constituent elements in materials, in this connection being similar to spectographic analysis.

The most important of the radiography papers from the civil engineering standpoint were presented by J. C. Hodge (Babcock & Wilcox Co.) on radiography in the welding shop, and by Norman L. Mochel (Westinghouse Electric & Mfg. Co.) on a comparison of x-ray and gamma ray methods. The need for non-destructive testing was first formally recognized by the 1931

A.S.M.E. boiler code and since that time much experience has been obtained in using x-rays to detect entrapped slag, cracks, porosity or incomplete fusion in welds. Mr. Hodge reported the results of a questionnaire returned by 35 individuals or companies using the radiographic process. Among these were the following: (1) there are 40 x-ray equipments in use in the country on regular examination of welded joints; (2) some 850,000 lineal feet of welded joints from ¼ in. to 5 in. in thickness have been examined to date by the x-ray method; (3) the Boulder Dam penstocks built by Babcock & Wilcox required the use of 270,000 ft. of x-ray film; (4) x-ray equipment for examination of field welds is increasing, and was used notably on penstocks for the plants of Norris dam, Boulder Dam and the New Kanawha Power Co.; (5) some 30 owners of x-ray equipment use it for experimental welds in grading or selection of electrodes and in determining weld procedure for a given job; (6) the capacity of tubes is either 200 kv. and 10 ma., or 300 kv. and 10 ma.; in a few recent cases 400 kv. 5 ma. tubes have been used; (7) radiographic examination is considered superior to other forms of non-destructive testing although a magnetic testing method is sometimes used as a supplement, to detect very small surface cracks; (8) x-rays will disclose major defects provided the defects have a section at least 2 per cent of the weld thickness. On welds 2 in. or less in thickness, all cracks can be detected, while on thick welds a special grid is required to eliminate scattered radiation and clouding of the film; also welds must be ground to uniform thickness.

In discussion, H. H. Lester, Watertown Arsenal, who used the first installation of x-ray equipment in this country in 1924, stated that in the manufacture of castings x-ray inspection was found to be too costly since it rejected too many castings which experience had shown were entirely serviceable; x-ray methods are now used only as an aid in developing improved technique and in redesigning castings, to reduce weight. In reply to a question, Mr. Hodge said it was not practicable to set up a standard of porosity measurement or to fix a limit of weld porosity yet. X-rays show porosity readily, but more experience is needed before rigid specifications are considered. He also explained that depth of defects, a dimension desired for chipping-out purposes, is determinable by taking double exposures of a lead marker inserted in the weld and using geometrical relationships in the calculations.

The use of gamma radiography, using radium salts as the radioactive source, stems from work at the U. S. Naval Research Laboratory, according to Mr. Mochel, whose questionnaire answered by 17 concerns revealed that all are using the technique and recommendations of this laboratory. The value of gamma ray processes begins where the usefulness of x-ray ends, due to the thickness of the metal. X-rays are effective up to about 4¼ in., while gamma rays have been used up to 10 in. thicknesses. The reason for this is that the shorter wave length of the gamma rays gives them greater penetration; it is stated that 1,000,000 volts would be required to produce gamma rays as compared with the largest x-ray tube which has a capacity of only 400,000 volts. The gamma ray process is also advantageous for examining complicated shapes, such as railroad frogs, valves and turbine parts, or in the field where the easy transportability of the radium salt capsules is a factor. All welds in the branches of the Boulder Dam penstocks were examined by gamma rays.

Cost comparisons between gamma and x-ray methods are difficult, and in Mr. Mochel's opinion somewhat pointless in view of the different fields of application. However, 200 mg. of radium sulphate cost about the same as a 300 kv. x-ray installation. In 1914 the cost of 1 mg. of radium sulphate was $180, in 1930 $70, and at present $55. It may be rented for $10 per 100 mg. for 24 hours.

In the x-ray diffraction methods, the reflected rays from the object being examined are caught on a film, and the various patterns or arrangements of diffraction lines that result are characteristic of certain conditions such as stress concentrations, the presence of alloys or special atomic arrangements. The papers in this field were largely concerned with chemistry and advanced metallurgy and have only remote application to common civil enginering problems.

Specification developments

Minor revisions of specifications, changes of specifications from tentative to standard and similar actions were too numerous even for listing. However, the more important developments are presented below. A total of 31 new tentative specifications was adopted, and 76 existing specifications were given the status of standard, so that they can be published in the 1936 Book of Standards.

Cement—Perhaps the most significant action taken by the convention was the adoption of a standard specification for high-early-strength cement, which includes a new definition for portland cement. By permitting small additions of materials other than gypsum subsequent to calcination, the new definition recognizes the manufacturer's need for grinding agents in producing fine cements and the consumer's need for additions that may aid high-early-strength, durability, freedom from bleeding and other desirable properties. The new definition states in substance that:

> Portland cement is the product obtained by pulverizing clinker consisting essentially of calcium silicates, to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulphate except that additions not to exceed 1 per cent of other materials may be added, provided such materials have been shown not to be harmful by tests prescribed by Committee C-1 and carried out by the Cement Reference Laboratory at the Bureau of Standards at the expense of the manufacturer of the additions.

Conformance with this definition required the inclusion of two further paragraphs in the new high-early-strength cement definition, to the effect that cement packages be marked to show the added materials and that bulk cement shipments be accompanied by a printed statement indicating the additions that have been made.

Two new committees are to be set up, one on policy with respect to the additions, which will be the present cement reference laboratory committee, and the other on tests and evaluation of results.

The action on the new definition killed the term "modified portland cements," which had been coined to cover cements with additions, and also resulted in the withdrawal of the tentative specification on high-early-strength "treated" cements. The new definition will be incorporated in the specification for normal portland cement when this is revised in the near future. The adopted standard high-early-strength specification includes an optional compressive strength requirement, and in connection with fineness prescribes a specific surface of not less than 1900 cm. per gr.

A specification for blended cements will be ready to be offered at the next convention, according to the committee that is studying the subject.

Work on the plastic mortar cube tests for cement is continuing. First results being disappointing, because different laboratories could not secure any uniformity in results, a new mixture including Ottawa sand and aggregate graded up to ⅜ in. in size is being tried at the Bureau of Standards.

Steel—In the field of steel, a new tentative specification for structural nickel steel was adopted to supersede the existing outdated standard. On check analysis the steel must show 3 to 4 per cent nickel, 0.85 manganese and not over 0.45 carbon. Tensile strength is 90,000 to 115,000 lb. per sq.in., yield point one-half the tensile strength but not less than 55,000 lb., elongation in 8 in. is 1,600,000, divided by the tensile strength and reduction in area is 30 per cent.

New tentative specifications were adopted for fabricated bar or rod mats and for welded wire fabric for concrete reinforcement.

The sub-committee on structural steel brought to virtual completion a specification for high strength silico-

manganese steel rivets suitable for use with silicon, nickel, and other high strength steels. At present there is only a specification for carbon steel rivets whose use is inefficient in highly stressed joints. After considerable discussion of the new rivet specification, ductility, the all-important characteristic in a high strength rivet was specified to be determined by an elongation in 8 in. of 1,650,000 divided by the tensile strength, giving about 20 per cent plus or minus. A remarkable period of service to this committee was ended at the convention by the retirement of A. W. Carpenter, engineer of bridges, New York Central Railroad, who has been chairman since 1922. He is to be succeeded by F. H. Frankland, chief engineer, American Institute of Steel Construction.

In the field of corrosion resistance, a new tentative specification covering a test for uniformity of coating by the Preece method (copper sulphate dip) on zinc coated wire was adopted.

Wrought Iron—A new tentative specification on single- and double-refined wrought iron bars was adopted. The tentative specification for wrought iron rivets was revised, raising the manganese requirement from 0.05 to 0.06 per cent maximum, and adding an elongation requirement of 22 per cent for rounds $\frac{1}{4}$ to $\frac{7}{8}$ in. in diameter, the larger size rounds to have the existing listed elongation.

Cast Iron—A new tentative specification for light weight and thin section gray iron castings was adopted. Revisions in the specification for cast iron culvert pipe are under way.

Chemical Analysis—The new committee on chemical analysis of metals organized last year to take over all such work in the metal field offered a new specification on methods of chemical analysis of steel, cast iron, open hearth and wrought iron for carbon, manganese, phosphorus, sulphur, silicon, copper, nickel, chromium, vanadium, molybdenum, titanium, and tungsten. These specifications supersede the existing methods of chemical analysis of plain carbon steel.

Concrete—Among the large number of recommendations affecting standards made by the committee on concrete and concrete aggregates and approved by the convention, several may be listed. Three new tentative standards cover (1) method of test for flow of portland cement concrete using the flow table; (2) a laboratory method of making flexure tests of concrete using a simple beam with third point loading (the center loading method being withdrawn); and (3), a method of test for determination of coal and lignite. A number of new definitions of terms relating to concrete and aggregate was approved. A proposed simplified practice recommendation for coarse aggregates made by the U. S. Department of Commerce has been approved by the committee on road and paving materials, and the sizes will be fitted into existing specifications and methods of test.

The Joint Committee on Concrete and Reinforced Concrete met during the convention and made further progress on its report; it is hoped that it can be completed next year. Since the committee was organized in 1930, 13 sessions have been held. Most progress and change will occur in the design section with special emphasis on columns, two-way slabs and continuous beam design; in the latter, moment coefficients are being eliminated in favor of definite and accurate analysis methods.

Timber—In the field of timber a new tentative specification was adopted covering zinc chloride preservative treatment. This is the first salt method recognized by the A.S.T.M.

In the specifications for structural wood joist and planks, beams and stringers, posts and timbers, the grade names have previously been used. The convention adopted as tentative a new specification identical in every way, but substituting stress values for grade names. For example, instead of "dense select," a certain type of beam or stringer will now be designated as "1800 lb. *f*."

Failures of heat-treated bridge wire

One of the most important events of the convention to the civil engineer was the presentation of a paper on the six-year Bureau of Standards study of the heat-treated suspension bridge wire that was removed from the Mount Hope Bridge in Rhode Island after an alarming number of failures occurred during the construction period in 1929 (*ENR*, April 11, 1929, p. 602, and October 10, 1929, p. 562). Prepared by W. H. Swanger and G. F. Wohlgemuth, of the Bureau staff, the paper was presented by Mr. Swanger. It will be published in some detail in a later issue, but its main content and conclusions are referred to here briefly.

The failed wire was a basic open-hearth steel, with approximately 0.75 per cent carbon content, drawn to 0.192 in. in diameter and brought to an ultimate tensile strength of about 220,000 lb. per sq.in. by a heat treatment consisting of quenching and tempering. The wire was galvanized by the hot-dip process. Such wire had never before been used for suspension bridge service, but was accepted on the basis of an elaborate series of tests of the type to which the more ordinary wire, whose high strength is obtained by cold drawing instead of by heat treatment, is subjected.

The Bureau of Standards investigation checked the acceptance tests on tensile strength, hardness, torsion, and bending, and extended studies of the microstructure of the failed wire disclosed no evidence of defective material or faulty heat treatment. Such cases of abnormally low strength or ductility as did occur were found to be associated with defects at the surface of the wire. Intensive search failed to disclose internal cracks or fissures as a possible cause of the failure.

The great majority of the wire failures occurred at the anchorages, and it was concluded that the cause of the failure was associated with stress conditions at these points. Because of the high elastic limit of the heat treated wire, provision was made for preforming each wire where it passed around the anchorage strand shoe by bending it around a sheave having about one-half the diameter of the anchor shoe. The theory was that the wire would then lay dead against the shoe, with no residual elastic bending stresses in the wire. Examination, however, showed that most of the loops, when hanging free around the anchor shoes, did not have the curvature of the shoes, and some had reversed curves, so that when constrained to the shape of the shoe they were subjected to high elastic bending stresses.

Since the fractured surfaces of the wires which broke on the bridge showed definite characteristics of fatigue failure, it was concluded that fluctuating stresses were the damaging stresses when the wires failed. Accordingly, in the test program, numerous specimens of both heat treated and cold drawn wire were subjected to various ranges of fluctuating tensile load while suspended over circular supports of the same radius of curvature as the bridge anchorages. The results showed that for equal ranges of tensile loads the endurance of the heat-treated wire was greater at high values of mean tensile load than at low values, and that for equal endurance a higher range could be applied at high mean loads than at low loads. Fractures were obtained with the heat-treated wire in 72 hours, with a maximum load as low as 5 per cent of the load necessary to break specimens in static tensile tests.

In explanation it was offered that a preformed loop deviating in curvature from that of the anchor shoe when subjected to a tensile load just sufficient to cause it to conform to the shoe would, upon release of a small portion of the tensile load, again revert to a position deviating from the curvature of the shoe, which would cause the outer fiber stresses in the wire to fluctuate. Hence the conclusion that the bending stresses would be greater at low loads than at high loads.

The fluctuating tensile load tests are believed by the Bureau of Standards investigators to have reproduced the mechanism of the fracture of the wires on the bridge; the appearance of the fractures produced in the laboratory, it is said, could not be distin-

guished from those that occurred on the bridge.

It was concluded that the way in which the failed wires were placed on the anchor shoes, the high elastic limit of the material, and the fluctuating loads on the wires during the construction period combined to produce a range of elastic bending stresses in the wires at the anchor shoes. The uniformly fine grained steel of the wire, surrounded by the brittle galvanizing and with numerous surface imperfections acting as points of stress concentration, offered inadequate resistance to the repeated elastic bending stresses. Fatigue fractures originating at the surface of the wires were the result. On the other hand, the fibrous structure of the cold drawn wire caused these cracks to be turned aside.

In discussion, A. V. DeForest, American Cable Co., expressed admiration for the paper, and the hope that the several divisions of the problem suggested by the research will be taken up separately and in more detail. The work shows definitely, according to Mr. DeForest, that surface is more important than has previously been considered, and that hot galvanizing on a rough surface is dangerous practice. Also that propagation of cracks must be studied, to devise tests that will determine the character of wire, such as was used on this bridge

E. E. Thum, editor, *Metal Progress*, stated that the data from the tests, although rather conclusively pointing to fatigue failure, nevertheless did not eliminate the possibility of creep stresses playing a part. With the wire stressed beyond its elastic limit by preforming, the addition of load which occurred during bridge erection added overstrain of slowly increasing intensity. Cracks formed in the brittle galvanizing, and the wire, being of fine grain structure, could not adjust itself by plastic flow as could a cold-drawn wire, with the result that the wire fractured, according to Mr. Thum's theory.

Next week the concluding part of this report will cover the papers presented on research in cement, concrete, metals and asphalt

Letters to the Editor

The Consulting Engineering Business

Sir—The Delaware River Joint Toll Bridge Commission contemplates building a new bridge over the Delaware River between Easton, Pennsylvania and Phillipsburg, New Jersey. Plans for this bridge have been prepared by the chief engineer and application has been made to the federal government for $2,000,000 to finance same. It was apparently considered desirable to employ a consulting engineer on this work. Accordingly, several engineers, specializing in this type of work, were invited to meet a committee of the Commission in the office of the chairman. These gentlemen were sitting in a room waiting to be called upon to state their qualifications when a secretary appeared and handed each applicant the following statement:

The functions of the Consulting Engineer shall be of an advisory nature and in this capacity will be exercised, whenever called on by the Chief Engineer to the Joint Commission, to pass upon debatable questions of design and construction; in disputes that may arise during the conduct of the work, or in connection with any other questions where the opinion, or assistance, of a third party may be of value; but all executive authority shall be vested in the Chief Engineer to the Joint Commission, who shall finally decide all matters and whose decision shall be final.

In general, the following recaptiulation will embrace the principal activities of the Consulting Engineer:

1. To check all calculations, plans and specifications prepared by the Chief Engineer, to insure their adaptability and accuracy.
2. To assist in having these plans and specifications approved by the proper governmental agencies, where and when necessary. This will involve conferences with these authorities.
3. To assist the Chief Engineer in analyzing bids of contractors.
4. As the work proceeds, to give the benefit of his advice to the Chief Engineer on questions of foundations and other matters, whenever called on by the Chief Engineer.
5. To assist and concur in the modification of plans, prior to, or during the progress of the work, should such action become necessary.
6. To give the benefit of his advice in connection with any disputes that may arise during the conduct of the work.
7. To give the benefit of his advice on any other questions that may arise, not covered by the foregoing.
8. To state definitely to the Commission the terms upon which an engagement as outlined would be undertaken.
9. At present, no funds are available with which to compensate a consulting engineer and as considerable preliminary work will be required in advance, therefore, any engagement will have to be predicated on the Commission securing funds at some future time. In case no funds can be secured, the consulting engineer agrees to waive all claims for his preliminary services.

This statement of the functions of the consulting engineer seems to me to be very enlightening and worth being brought to the attention of the engineering profession. The duties of the consulting engineer seem to be confined principally to the use of a whitewash brush. It is also indefinite as to the number of times he might be called into consultation. Paragraph 9 is worth reading.

Needless to remark, the Commission had no difficulty in securing the services of a consulting engineer upon favorable terms.

A READER

May 16, 1936.

More on Puzzolanas

Sir—I have read with interest the letters of Edw. W. Scripture (*ENR*, March 19, 1936, p. 431) and Bailey Tremper (*ENR*, Feb. 13, 1936, p. 257) dealing with the use of puzzolanas and puzzolanic cements. Both of the authors quoted the work of Keiley, Troxell and Davis (*Journal, Am. Conc. Institute*, Vol. 7, 1935), on the volume change of puzzolanic cements but from different viewpoints. In addition to this reference there are many published reports of work in foreign countries dealing with the shrinkage of puzzolanic cements. They do not all substantiate the work of Davis. This does not mean that they are contradictory but that they were made under different conditions. In referring generally to the qualities of a type of cement more than one authority should be given or the conditions of test used by the quoted author should be given and commented upon.

Bailey Tremper quotes a statement of Pierre Periani (XVth International Congress of Navigation, Vienna, 1931, Paper No. 100). From the quotation given, it might be understood that Periani did not favor the use of puzzolanas. As Edw. W. Scripture points out, Periani is condemning the "mere adding of portland cement to ground puzzolanas." A substantiation of this contention can be found in the following quotations.

"The puzzolana added being a substance with an acid reaction, ought to fix the common lime as it is given off by the cement and produce monocalcic aluminates and silicates which are fixed salts; but this does not happen completely because the development of the lime in cement takes place more rapidly than the action of acids in puzzolana on lime.

"Consequently the two phenomena are neither equivalent nor simultaneous and the dilution of lime still takes place. The decay of structures will be less but will still happen; in order to avoid it altogether, we must increase and accelerate the hydraulic activity of puzzolana." . . .

"This strengthening is obtained by submitting puzzolana of suitable granulometric quality to a process of torrefaction followed by a tempering. . . ."

The quotation of Bailey Tremper was accurate but did not present a true picture of the work and conclusions of Pierre Periani. This letter is a criticism only in so far as it calls attention to the fact that authorities in their public discussions should qualify their remark so that those less well informed may not be led astray.

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April 16, 1936.

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July 9, 1936

A Road Task Ahead

ROAD TRANSPORT has been favored with two decades of wise federal support by Congress. Action by the last Congress assures the continuation of these tried and proved federal-aid policies for three years, beginning with present month, increases the amount of federal aid, and extends it over more types of highway projects. In brief federal-state road funds until June 30, 1939, are stabilized at $1,026,000,000, of which the federal share is $601,000,000 and the share of the states is $425,000,000. The excess of federal over state funds provides for roads in federal lands and for removal of grade crossings. The extent of the benefit of this great sum of money in improved roads is wholly of state determination, first, in promptly placing improvements under contract, and, second, in conserving highway tax receipts from diversion. If either of these requirements is not met by the states the amount of federal-aid they will receive is adversely affected. Road transport has then the definite task ahead of making sure that the states do their parts. It must fight diversion of state road funds; it must see that wise road extension and improvement are planned and put under construction. With the growing upkeep needs of the roads already in service, the billion dollars for new construction will call for all the state road tax money now being received. The obligations are plain: if the liberal federal support of roads by the national administration and by Congress is to be justified, highway transport interests must show their ability to utilize this aid in extending public road transportation. The right to federal assistance in roadbuilding exists only in the prompt and wise use of this aid.

Process or Product?

A LONG BATTLE to relax the rigidity of the portland cement definition in the standard cement specifications ended last week in an agreement to admit minute amounts of admixture under special approval of the cement committee of the American Society for Testing Materials. In a way the fight over the final agreement was a tempest in a teapot, for the permissive loophole now provided is smaller than others that had previously existed and had been widely utilized by cement manufacturers to add mechanical and other correctives. However, the change is interesting aside from its immediate bearing on cement, because it touches the old but never obsolete issue of whether a product specification should restrict the process of production or whether it should confine itself to fixing the required test properties. What the user wants is the product, and the properties which it possesses and makes available to him; he cares nothing about process of manufacture in itself. But sometimes a particular process of manufacture confers (or is believed to confer) certain properties that escape detection or verification in the acceptance test—even in the most refined check test. Therefore, limitations are often imposed on the process of manufacture. It would be interesting to review the chief materials specifications of civil engineering to see how far process requirements have maintained themselves, and to determine whether their survival is in all cases attributable to backwardness of the manufacture or testing arts, or whether traditional adherence to antiquated customs on the part of the specification writer may be involved. We venture to guess that some influence of diehard conservatism might be discerned, but that more blame would fall on the limitations of the testing engineer's knowledge. So long as he is unable to define the toughness of steel by precise measure, or to verify the long-time behavior of cement in advance, he will probably find comfort in process requirements—provided they are progressively kept in tune with the manufacturing art.

Water's Dual Role

JUDGING FROM SUBJECTS covered in deliberations of the American Water Works Association at Los Angeles early in June, the water system of the west in which water does not fulfill a dual role is the exception rather than the rule. In raising O'Shaughnessy dam and in developing Mono Basin water, San Francisco and Los Angeles respectively are spending large sums solely to increase power production with domestic water supplies. Water developments for combined irrigation and domestic systems are numerous, and Los Angeles definitely expects to and does pump back into her city reservoirs, from an underground collecting basin, more than 27 per cent of the water sold to irrigators in the San Fernando Valley. San Diego's reservoirs are used extensively for such recreational purposes as boating and fishing. Consideration of these instances of dual use cannot but raise question as to whether engineers are overlooking other opportunities for fuller use of water brought to our cities at great expense. In air conditioning, for example, is it possible that water used for cooling might be passed on to water heaters or fed into a separate system used for flushing purposes?

A Mystery Studied

THE UNUSUALLY MYSTERIOUS breaks of quench-tempered suspension bridge wire that were the sensation of 1929, when the Mount Hope and Ambassador bridges were under construction, have been the subject of six years of patient study in the laboratory of the Bureau of Standards. As reported before the American Society for Testing Materials last week, the bureau explains the breaks as due to the vulnerability of this type of wire to mechanical injury in placing it in the bridge and looping it around the strand shoes; in turn this susceptibility to injury is chargeable to the grain structure of the quenched wire, which differs from the structure of normal bridge wire. The latter wire is drawn after it has undergone a refining and hardening heat treatment, and through this drawing process the grains are stretched out in scale-like form into an overlapping, well-knit assemblage which does not offer ready opportunity for incipient cracks to extend from surface nicks through the body of the wire. But the heat-tempered wire, of which the orignal Mount Hope bridge cables were built and which developed a multitude of breaks at the strand shoes that threatened the fall of the whole structure, lacks this drawing-out of the grains and preserves the brash crystalline structure of heat hardened steel. Experience in the field of heat tempered springs affords much precedent for such cracking and rupture. While the Bureau of

Standards' explanation does not meet all the questions raised by the Mount Hope history, it is highly important to the civil engineer in showing that he may need to keep himself informed on the influence of grain structure, and also that he may have to consider the fatigue effect of fluctuating stress.

The Divine Right of Mill Buildings

AN EXAMINATION of almost any college textbook will reveal that, in so far as industrial buildings are concerned, it is reflecting practices that are at least a decade out of date. Whether students are being instructed in the divine right of mill buildings as expounded by these texts is not known, but their existence constitutes an invitation to misinformation. Worse still, they give the student no idea of the importance of industrial building design as a fertile field for the exercise of vision and ingenuity and as an undeveloped field for job opportunities after graduation.

An industrial building, if one is to judge from the textbooks, is a structure that may easily be thrown together by any college graduate who has had the foresight to keep his class notes on the design of a Fink roof truss, a crane girder and perhaps an eccentrically-loaded column. As a matter of fact, industrial buildings are seldom mentioned in the textbooks by name, but instead are referred to as mill buildings. A quarter century ago this terminology was perhaps permissible. Today, mill buildings are only one type among many in the field of industrial buildings. If we may judge from what has been happening during the past year and a half, the industrial building types of the future will be even more diverse. And as a corollary, knowledge of elementary stress analysis alone will hardly serve as sufficient equipment for the engineering graduate who may find himself confronted with the problems of industrial building design.

The industrial building developments of the past two years have a certain dramatic quality because for nearly five years practically no building of this type was done in the United States. When work did begin it gave evidence of a vitality that previously had been lacking. Precedent-worship had lost its appeal, for one thing. But most important, the industrial building owner had found the time to scrutinize his plant in the same critical manner as he had always scrutinized his product—and he had not found it perfect. Consequently some of the new buildings are distinctly better than their predecessors and a few are radically different. Whereas the conventional mill building is made up of bents consisting of columns and trusses, modern industrial buildings contain rigid frames, rolled-section steel arches, concrete arches, plywood frames, and expanded metal columns. To these frame elements have been added new light-weight floors of numerous designs and the windowless solid wall. These and many other innovations reflect the results of sober thinking during the five-year layoff when maintenance charges were eating up capital surpluses. They provide a backlog of practice that can be studied with profit by every engineering college student.

It would seem logical for engineering educators to consider ways and means by which these new industrial building developments can be integrated with the civil engineering curriculum. It is eminently desirable that so fertile a field for design ingenuity should be better planted and cultivated. Students who leave college believing in the divine right of mill buildings are handicapped from the start. Granted the superiority of the roof truss and the crane column as subjects for exercises in elementary stress analysis and structural design, it must be recognized that time marches on. Many new types of industrial buildings have been built, others are on the drawing board or exist in embryo in some active brain. If the student can be made to feel that the sky is the limit in industrial building design, that vision pays dividends and that imagination is welcome, he will bring to his life work a much needed kind of talent.

Practical Confirmation

COMING BACK once more to the notable Harvard Conference on Soil Mechanics and Foundation Engineering of two weeks ago, we think it is worth while to emphasize one point as preeminently significant to the foundation engineer. This point is the accumulation of convincing proof by large-scale field experience that densification or consolidation of clay soils to a harder state by the squeezing out of water goes on precisely in accord with theory.

Theoretical analyses worked out 12 or 14 years ago and perfected by subsequent experimental work indicated that such consolidation under load causes nearly all settlement of structures—excluding the relatively few cases of settlement of sand foundations. They showed that a given clay at a particular voids-ratio or water content has a certain definite ability to bear load; that under heavier loading it compresses to smaller voids-ratio; and that this process, which involves the slow squeezing out of water through the exceedingly fine interstices of the clay, continues at decreasing rate for a long time. If the permeability of the clay is measured in advance and the relation between voids-ratio and load capacity also is determined by test, the rate of consolidation of the clay under any specified load can be predetermined.

A specially brilliant demonstration of the precision of settlement forecasting thus made possible was furnished by observations of settlement under embankments of the Muskingum flood-control dams during the past year; the observed settlements checked the calculated settlements with remarkable fidelity, as to both amount and distribution. But the case by no means rests on one case of proof; numerous other observations at home and abroad furnish independent verification. It follows that the consolidation theory may now be applied with all confidence—provided of course that the soil is substantially uniform and that its properties are first measured with the necessary care.

A corollary of independent importance is that when the loading of a clay soil proceeds too fast a considerable part of the load will be carried for a time by the water contained in the pores. During this process large hydrodynamic stresses may exist in the clay mass; they may so reduce the frictional stability of the clay as to cause a flowing (shearing failure) of the foundation soil. Engineers have long been troubled by such flows, but could not account for them quantitatively or predict them dependably. Now, soil study has been able to account for these puzzling phenomena of plastic soils, and the foundation engineer is enabled to construct more safely and more surely.

CURRENT NEWS

PWA to Bar Irregular Bidders

New advisory board will hold hearings before barring contractors, charged with fraud, from future bidding

PUBLIC WORKS Administrator Ickes has created an advisory board to consider charges against contractors against whom evidence has been received indicating fraud or attempted fraud in connection with bids or contracts.

The contractor will be notified of the charges, and may file a rebuttal. If he fails to do so within fifteen days, Administrator Ickes will decide, on the basis of the evidence at hand, whether to bar the contractor from bidding on PWA projects for a reasonable period. If the contractor desires to answer the charges, the new board will conduct a hearing and recommend to the administrator whether the contractor should be barred from future bidding and, if so, for how long.

The provision for a hearing is more liberal than previous practice, as several instances have been brought to the attention of the Associated General Contractors in which, it is claimed, contractors have been barred from bidding, without a hearing.

Toll-Bridge Bill Vetoed

President Roosevelt vetoed on June 30 a bill which would have permitted federal highway funds to be used to convert toll bridges into free bridges. The bill would have permitted payment to a state, from its apportionment of federal-aid road funds, of 50 per cent of the cost of any toll bridge, built between March 3, 1927 and the date of passage of the act, which was made a free bridge before July 1, 1938.

The President in his veto message stated, "The effect of this bill would be to divert funds appropriated for carrying forward our system of federal-aid highways through the construction of new roads and new bridges to the payment of one-half of the construction cost of bridges already built. The bridges in question were constructed by the state as toll bridges and were to be operated as such until the revenues from their tolls should liquidate the cost of construction, when they were to become free bridges. This is the general theory upon which public toll bridges are constructed, and I can find no justification for diverting federal road funds for the purpose of freeing such toll bridges."

The President also vetoed a bill which would have exempted publicly-owned interstate highway bridges from state, municipal and local taxation.

First West Slope Water For Denver System

When water from the western slope of the Rocky Mountains was turned through the Moffat tunnel on June 10, it was the climax of a 30-year old project to bring in an ample supply of water and remove a threatened limitation to Denver's growth. The city has faced the possibility of a shortage ever since it acquired the Denver Union Water Company's system in 1918.

The completion of the tunnel portion of the project was marked by appropriate ceremonies as H. S. Crocker, consulting engineer on the project, pressed a button opening a motor-operated gate that turned 80 sec.-ft. into the tunnel at the west portal. This flow was increased to 200 sec.-ft. within a week when the new ditches carrying the water from south Boulder Creek, below the eastern portal, to Ralston Creek had been soaked sufficiently to prevent cave-ins of embankments. Work is under way on the Ralston Creek dam and filter plant, other units in the project. The work is being financed by PWA funds.

WATER EMERGING from the Moffat tunnel is carried in ditches to Ralston Creek.

Drought

Washington Correspondence

SERIOUS DROUGHT continued to spread in the grain states this week, with no immediate relief forecast by the Weather Bureau. Except in the Southeastern states, where general rains have effectively relieved drought conditions, the Weather Bureau reported July 7 that there had been no useful rain. The first three days of July brought rains in most places from the Potomac, Ohio and lower Missouri rivers southward, but no material relief was reported for other drought sections. The bureau previously reported that the present urgent need for rain is more widespread than was the case in either 1930 or 1934 at this season of the year. In those years the situation was not nearly so critical at the end of June, but in both instances the drought was most severe and caused the greatest crop damage during July and August.

Effect on water supplies

The U. S. Geological Survey reports that, so far, the drought seems to have affected only soil moisture. To date there seems to be no serious shortage of surface or ground water supplies. Irrigation has been affected in only a few regions. The U. S. Bureau of Reclamation reports that stored water supplies on its projects are ample, except on the Belle Fourche project, South Dakota, and the North Platte project, Wyoming and Nebraska. On these it will be necessary to pro-rate water.

WPA Administrator Hopkins made public a report by WPA's division of social research in which it is stated that the immediate program of relief and a long-range program of regional rehabilitation are being plotted on the basis of improved land use. The distress in the drought areas is attributed to mistaken methods of land use extending over many years. The report offers three suggestions: (1) Conversion of cultivated crop land to permanent pasture range in many parts of the area. (2) Enlargement of small holdings, unsuited to crop production and yet not large enough for economic cattle units, to make possible greater emphasis upon grazing and less dependence upon crops. (3) Aid to needy families to move to other regions where better farming opportunities may be found.

Removals planned

Removal of farm families from certain parts of North and South Dakota, Northwestern Texas, and parts of Colorado and Kansas, where wind erosion has been most severe, was recommended as particularly desirable.

To facilitate rapid transfer of feed and livestock in drought-affected areas, a federal livestock feed agency, operated by the Bureau of Agricultural Economics, opened its headquarters in Kansas City on July 8.

Mathieu Photo

HINGELESS STEEL ARCH OF RECORD LENGTH CLOSED AT NEW YORK

The 800-ft. main span of the Henry Hudson Bridge over the Harlem River at New York, notable for being both the longest hingeless arch and the longest arch of plate-girder construction in the world, was closed on July 8 by the insertion of a key section, 2½ ft. long, at the crown. Closure was accomplished by the aid of horizontal jacks bearing against brackets attached to the flanges of the ribs at the crown and by manipulation of jacks in the base of the falsework bents set about 200 ft. shoreward of the center of the span. Each half arch rib had been erected on two falsework bents 100 ft. and 190 ft. out from the abutments. These bents, of two steel columns, were supported by groups of steel H-section piles driven to rock which, at the deepest point, was 90 ft. below the water surface. Stiffleg derricks over the abutments erected the steel out to the first falsework bent, after which erection travelers were placed on top of the ribs. With the arch closed another steel traveler will start from one end erecting the spandrel posts and the deck steel.

The two arch ribs of silicon steel are of box girder type 12½ ft. deep and 3½ ft. wide; they are spaced 50 ft. on centers. The arch has a rise of 120 ft. and provides a 140 ft. shipping clearance at the center.

In addition to the main span the bridge includes steel viaduct approaches 300 ft. long at either end. Also incorporated in the project are approach roads connecting on the south with Riverside Drive, in Manhattan, and on the north with Westchester County's Sawmill River Parkway via new state highways through Van Cortlandt Park.

The $3,000,000 cost of the work will be amortized through tolls paid to the Henry Hudson Bridge Authority, a public body. The bridge is being erected by the American Bridge Co. The consulting and supervising engineers are Madigan & Hyland, while the design was carried out by Robinson & Steinman and the architectural detail by Aymar Embury II.

Bids Called for Bridges On Pan-American Highway

Bids for three spans on the route of the Pan-American Highway, have been called for by the U. S. Bureau of Public Roads. The bids are to be opened July 28.

Work has already been started on the substructure of all three spans, and construction is to be pushed as rapidly as possible so that the bridges can be thrown open for traffic by June 30, 1937.

The span over the Chiriqui River in Panama is estimated to cost $162,451. The second, over the Chaluteca River in Honduras, is estimated to cost $229,131. The third, over the Tamasulapa River, in Guatemala, is estimated to cost $86,297. The three countries are cooperating with labor, local materials, and, where possible, with equipment.

All three will be suspension bridges. Among the factors influencing this decision was the virtually certain floods that will come in all three streams in the wet season. In addition to this, large boulders were found in the river beds, doubling the normal difficulties of foundation work, and making the construction of falsework a difficult task.

The Chiriqui bridge, founded on rock, is to be of the single span suspension type, 400 ft. between piers, and with approach span stays unloaded. Concrete anchorages are used.

The roadway is to be 20 ft. wide, of concrete slabs resting on a silicon steel flooring system. The stiffening trusses are to be of carbon steel.

The Chaluteca bridge is also a cable suspension, with two main spans of 330 ft. each, and two 110 ft. approach spans. It will differ from the Chiriqui construction in that the cables will not be wrapped, but will be held together by clamps, with a small clearance between strands. The Chaluteca span cables will not be continuous as in the Chiriqui bridge, but will run from the anchorage, at either end of the structure, over the nearest tower, and to an anchorage in the second span, thus reducing the cable length. The roadway will be similar to that on the Chiriqui bridge.

The plans for the Tamasulapa bridge call for eye-bar construction, with a central span of 240 ft. and approach spans of 100 ft. each. Aside from the difference in the cables, the construction will be virtually the same as with the other spans.

Use of Platte River Water By Tri-county Project Limited

Water from the Platte River may not be diverted and used for irrigation outside the basin of the Platte River, according to a ruling delivered by the Nebraska supreme court on June 29.

Construction is now proceeding on the Tri-county Power and Irrigation District project, which has been allotted $10,000,000 by PWA. The original plan, which was modified by the court's ruling, called for the diversion of a portion of the tailwater from the power plant into the watershed of the Republican River to be used for irrigation.

Project officials are preparing plans, to be submitted to PWA, which will change the area to be irrigated so as to bring it entirely within the basin of the Platte.

Navy Civil Engineer Corps To Fill Vacancies

For the first time in more than ten years, the Civil Engineer Corps of the Navy is looking for engineers from civil life to fill vacancies in the corps. Examinations are to be held in October, at points not yet determined, following receipt of applications which must reach the Chief of the Bureau of Yards and Docks, Navy Department, Washington, not later than Sept. 15. To qualify, candidates must be engineering graduates with at least three years practice (two years after graduation), must be between 22 and 30 years old, and must have no physical impairments. The examination will cover a substantial range of civil engineering subjects.

The examination is to fill vacancies in the grade of assistant civil engineer, C.E.C., U. S. Navy, with rank of lieutenant (junior grade).

Supreme Court Upholds Arkansas Sales Tax Ruling

The Arkansas Supreme Court has ruled that contractors must pay the 2 per cent state sales tax on all materials used in construction. The decision upholds a previous ruling of the Pulaski county chancery court (*ENR*, June 11, 1936, p. 860) in a suit entered by M. E. Gilioz, Williams Bros., Inc., and C & M Construction Co. seeking to restrain the Arkansas state revenue commissioner from collecting the sales tax on $681,615 in materials used in construction of a water supply system at Fort Smith, Ark.

No Projects to be Started Under Omnibus Flood Bill

Congress failed to appropriate the $50,000,000 authorized to be spent during the present fiscal year on 200 projects to cost the federal government $300,572,300, authorized by the omnibus flood control bill. Consequently, none of the projects can be started until Congress meets again next January.

The omnibus bill gave to the President the selection of the order in which the various projects should be undertaken, and first steps have been taken to form an interdepartmental committee to study national flood-control problems and select those projects which will be started first when funds are made available.

Because the omnibus law adopted the policy that local governments provide lands and rights of way, it is probable that the flood-control activities of the local authorities will have a marked effect upon the order in which projects are started. Failure to secure the necessary lands is expected to act as a bar to immediate prosecution of many plans, even when an appropriation becomes available.

New Hydraulic Laboratory For Colorado State College

An addition to the hydraulic laboratory at Colorado State College at Ft. Collins provides 11,300 sq.ft. of additional floor area. In addition to facilities for models, it provides a rating tank 5 ft. wide, 5 ft. deep, and 250 ft. long. The work was financed by WPA funds, plus contributions from the Colorado Experiment Station and the Bureau of Agricultural Engineering.

The old laboratory, built in 1912 and enlarged in 1915, was the scene of researches leading to the development of the Parshall measuring flume, the adjustable-tube orifice meter, the vortex tube, and a grating type of sand trap. Since 1930 the reclamation bureau has used the laboratory for model tests on spillways, penstocks, gate towers, sluice gates, and dam crests for the Boulder, Norris and Grand Coulee dams.

Among those taking part in the dedication ceremonies were Dr. Charles A. Lory, president of the Colorado State College; S. H. McCrory, chief of the United States Bureau of Agricultural Engineering; W. W. McLaughlein, chief of the Division of Irrigation, United States Bureau of Agricultural Engineering; R. F. Walter, chief engineer of the United States Bureau of Reclamation; M. B. Hinderlider, Colorado state engineer; and Dr. E. T. Sandsten, director of the Colorado Agricultural Experiment Station. R. L. Parshall, director of the laboratory, presided.

Federal Power Commission Will Set Up Regional Offices

For the first time in its history the Federal Power Commission is planning to decentralize. It will establish five regional offices, to be located in New York, Chicago, Denver, San Francisco, and Atlanta. These offices will be for administrative purposes only; plans and policies will still be centralized with the commission in Washington.

The greatly increased duties imposed upon the commission by the Utility Holding Company Act of 1935 are largely responsible for the establishment of the regional offices, which are expected to facilitate contacts with utility companies and state regulatory bodies remote from Washington.

The New York and Atlanta offices will be opened immediately, in charge of Robert H. Barclay and Major A. R. Wellwood, respectively. The other three offices will be established as soon as preliminary arrangements can be completed.

Somervell to Head WPA In New York City

Lt. Col. Brehon Burke Somervell, U. S. Army engineer in charge of the Florida ship canal, has been appointed WPA administrator for New York City. He will take over the position on Aug. 1, succeeding Victor F. Ridder.

Colonel Somervell is a graduate of West Point. During the war, he served abroad on various construction projects with combat troops and in the service of supply, and was made assistant to the chief engineer, A.E.F. After the war he served as district engineer or as assistant in Pittsburgh, Portland, Boston, Providence, New York, Washington, Norfolk, and Memphis. He also served as special assistant to the president on the Mississippi River Commission.

After the armistice Colonel Somervell was assistant to Walker B. Hines in making allocation of river shipping in Europe under the treaty of Versailles. Later he made a survey of navigation on the Rhine and Danube rivers for the League of Nations, and more recently was a member of a board which made a general economic survey of the Republic of Turkey.

Colonel Somervell has served as executive officer of the Division of Application and Information of the relief work program, and is at present in charge of the Florida ship canal.

Contract Awarded For Bartlett Dam

The contract for the construction of Bartlett dam on the Verde River in Arizona was awarded on July 6 to Barrett & Hilp, of San Francisco, and Mocco Corp. of Clearwater, Cal., on their joint bid of $2,228,272.

Bartlett dam, a part of the Salt River federal reclamation project, will be the highest multiple arch dam in the world. The dam will be 270 ft. high, 14 ft. higher than the Lake Pleasant dam on the Agua Fria River, also in Arizona, which is at present the highest multiple arch dam. It will have a crest length of 750 ft. The dam will consist of ten reinforced concrete arches, supported by nine hollow reinforced concrete buttresses spaced 60 ft. apart. There will be a short gravity section at each abutment. A concrete-lined, open channel spillway controlled by three 50x50 ft. gates, will be located in the right abutment. The outlet works will pass through one of the arches.

Among the principal items of work involved are: 337,000 cu.yd. of excavation; placement of 163,000 cu.yd. of concrete; installation of 9,200,000 lb. of gates and hoists, valves, trash racks, pipes, reinforcement bars, and miscellaneous metal work.

Kettle Falls Power Plant Application Denied

The Federal Power Commission, in an order dated July 1, denied the application of the Washington Water Power Co. for a construction license covering a dam, reservoir, power plant, and appurtenant works at Kettle Falls on the Columbia River in Washington. The commission found that the proposed development would not be in the public interest, because it would interfere with the general development of the Columbia basin as proposed in a War Department report dated March 29, 1932. In particular it would interfere with the high dam to be constructed by the federal government at Grand Coulee, on which construction work is now in progress.

Bituminous Road Conference At Glacier Park Sept. 8-10

The second annual bituminous road conference, conducted by the Montana state highway department, will be held Sept. 8, 9 and 10 at Many Glacier Hotel, Glacier National Park, Mont. Highway engineers of Western and Midwestern states, especially those holding technical positions in bituminous road construction and maintenance work, have been invited to participate in the three-day session. The first conference, held last year at Butte, proved such a success that it was decided to make the conference an annual affair. Registration at Butte was over 200; indications already point to an attendance of 500 at the coming meeting.

A novel plan of presentation of papers has been worked out, which promises a most interesting technical discussion of the subjects. Three papers only will actually be read at the meeting, one on each of the following subjects: Developments and Fundamentals of Successful Bituminous Practice; Developments in Practical Design and Construction of Bituminous Surfaces; and Maintenance of Bituminous Surfaces. The various states showing an interest in the conference have been divided into seven groups. Three engineers in each of the seven groups have been assigned one paper on each of the three main subjects, a total of 21 papers in all. Before the conference convenes, a chairman in charge of each subject will analyze the papers submitted and present to the session a summary gleaned from the various presentations. The reading of each summary will take only an hour or so, to be followed by a half-day discussion of each, conducted by a conference board. Each of the individual papers will be available to delegates desiring them.

The three chairmen of the main subjects will be Prof. F. C. Lang, engineer of tests, Minnesota highway department; N. F. McCoy, U. S. Bureau of Public Roads, San Francisco; and H. G. Nevitt, Socony-Vacuum Oil Co., Kansas City, Mo. A fourth paper, "A Review of Analytical Engineering Methods as Applied to Bituminous Construction," will be presented by Prof. L. D. Conkling, Montana State College.

Arrangements for the conference are being made by D. A. McKinnon, chief engineer, Montana state highway department, Helena, Mont.

SAN GABRIEL DAM NO. 1 looking downstream and showing operations of dumping, spreading, sprinkling and tamping. In the upper right center background can be seen tunnel and bunkers in quarry No. 10.

Court Upholds Assessments For Code Enforcement

The Wisconsin Supreme Court has upheld assessments on industries to pay for enforcing codes under the Wisconsin Recovery Act.

The case arose when Wisconsin Contractors, Inc., an association of contractors in the state, in one of its bulletins, advised its members not to pay assessments for enforcement of the contractors code on the ground that such assessments were unconstitutional. The Wisconsin Trade Practice Commission, which enforces the codes, petitioned the court to accept original jurisdiction in the case.

The court found that collections have always been made from insurance companies, public utilities, and similar businesses for regulating those businesses. It stated, "If the exaction is in aid of regulation and for the purpose of eradicating abuses there can be no serious question of the power of the legislature" to provide for code assessments.

Experts Named to Seek Cause of New York Building Collapse

A committee of experts has been named by the district attorney of Bronx County, New York, to look into and report on the cause of the collapse of a large section of an apartment house under construction on East Mosholu Parkway South, a collapse in which 18 men lost their lives, (*ENR*, June 25, p. 930).

The committee consists of Francis A. O'Hare, E. W. Seelye, and H. G. Balcom, engineers, Leonard Schultz, architect, and J. S. Davis, chemist of the Robert W. Hunt Co.

Washington Highlights

By Paul Wooton

No hope that PWA will finance San Francisco's proposed subway system is held out by Administrator Ickes. He said he told Mayor Rossi to file an application, and that PWA would consider it, but that he did not give him any encouragement.

Inclusion of a few low-cost housing projects in the new public works program is regarded as probable by PWA Administrator Ickes. Construction probably will be limited to New York City and Cincinnati, as these, apparently, are the only cities which are able to qualify as sponsors of projects on a loan-and-grant basis. Both Langdon Post, of the New York Housing Authority, and C. A. Dykstra, city manager of Cincinnati, have discussed the proposal with Administrator Ickes. He expects that the New York Authority may file applications covering two or three new projects. Cincinnati also is expected to file for a new project. Cincinnati will require only a grant, according to Ickes, as it is in a position to market housing bonds for the remainder of the cost. Grants will amount to 45 per cent of cost.

Army engineers know of no use that they can make of the village constructed in connection with the Passamaquoddy project. Use of the village by the Veterans Administration is under consideration but no practical plan has been evolved. The buildings are not suited for a CCC camp. Dexter L. Cooper is preparing a report which may cover temporary utilization of the village. The Cooper report is expected to recommend that the larger project, including Canadian as well as American waters, be considered.

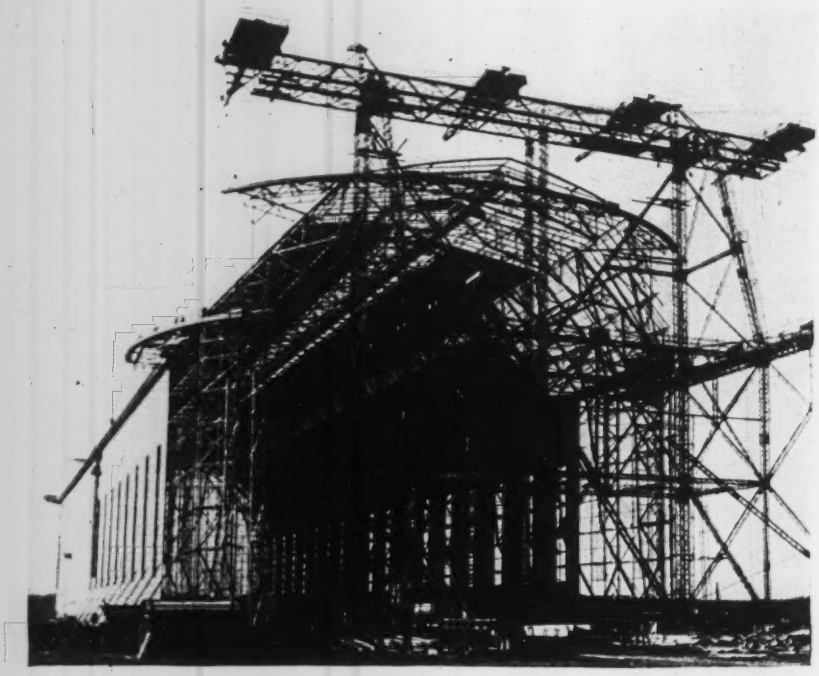
Progress on San Gabriel Dam

Rapid progress is being made on San Gabriel Dam No. 1 under construction by the Los Angeles County Flood Control District. In the early part of June 2¼ million cu.yd. had been placed in the dam, or about 20 per cent of the total yardage. The surface was being raised an average of 1 ft. per day, which represented a total delivery to the dam of about 12,000 cu.yd. in two 8-hour shifts.

Fines for the impervious core of the dam are being taken from a 1½ million-cu.yd. deposit about one-half mile upstream. Here ideal loading conditions obtain, with a downgrade haul to the dam, and one-yard trucks are loaded and dispatched to the dam at the rate of about one per minute.

From the rock quarry (Quarry No. 10, just downstream from the dam on the left bank) which has been operated for several years, the material now excavated goes into the dam in two classifications: "fines" includes everything that goes through a 6x9-in. grizzly, while everything rejected by this grizzly is rated as coarse material.

A gravity loading method now used in the quarry involves a concrete tunnel (built in the open and later covered with material) on a 10 per cent grade. The tunnel provides a one-way roadway under the excavated material. Trucks enter at the uphill portal, the motor is switched off and the truck coasts down to a loading position beneath the grizzly. The grizzly then is operated enough to load the truck, after which the truck coasts on out of the tunnel and is followed by another empty. Gasoline engines thus can be used legally on trucks operating through a tunnel. Trucks through the tunnel get only coarse material rejected from the grizzly. The fines go down into a bin over a conveyor and are elevated to bunkers also delivering by gravity to trucks.



ZEPPELIN HINDENBURG'S HOME HANGAR IN GERMANY

When the Zeppelin *Hindenburg* leaves Lakehurst, N. J., for a trans-Atlantic flight, her destination is the new plane and airship port at Frankfort on Main, Germany, where this hangar was recently completed for her use. The new field, privately owned, has an area of about 700 acres of which some 200 acres are devoted to airship operations. Its elevation, about 360 ft. above sea level, allows an increase of several tons in load carrying capacity for airships, as compared to the airport at Friedrichshafen, formerly used.

The new hangar, located in the southern part of the 7,200x5,250 ft. field, is one of the largest yet built, having clear dimensions inside of 900x170 ft. and a usable height of 167 ft. Of steel construction, its total weight, including the 400-ton doors, is 2,600 tons. The roof trusses are three-hinged arches raised above the floor on A-frames. They are spaced about 40 ft. apart. At each end of the hangar two cantilever roof trusses support a transverse member which carries the mid-section of the upper door guide structure. Sway bracing frames are used between the last two roof trusses at either end.

In order to avoid air currents, dangerous to the maneuvering of airships, the doors are semicircular in shape. When opened, they revolve to positions along the walls of the hangar. Within the hangar are installed four cranes to permit easy access to all parts of the airship and special girders to suspend the ship when deflating the gas cells.

The side walls of the hangar consist of brick for the lower 9.2 ft., while the remainder of the walls and the doors are covered with corrugated asbestos-cement board. The flat parts of the roof are covered with precast pumice-concrete plates and insulated with asphalt-impregnated cardboard. Corrugated asbestos-cement is used on the sloping parts of the roof. The entire framework is built of high strength ST52 steel.

Erection of the framework was carried out by means of a traveling scaffold equipped with overhead cranes. Erection began at the western end of the hangar, and the first framework set up had to be supported by two laced columns 164 ft. high until erection had passed mid-hangar length, permitting the longitudinal sway bracing to be erected.

The general contractor on the work was B. Seibert of Saarbrücken. Chief Engineer Möckel of this firm assisted by John S. Seiferheld, who supplied the above information, planned the entire project. Professor Knapp of Darmstadt was chief supervisor.

New York Engineers Club Plans Office Building

Plans for an office building on a site adjoining the Engineers Club on West 40th St., New York, have been filed with the building department of the city. The club house is located at 32-34 West 40th St. The club owns the remodeled dwelling houses on each side, having some of its facilities in those houses. The present plan, which is still in a formative stage and will not be crystallized until fall, is to replace the house on the east side of the club with a 16-story office building about 30 x 90 ft. in plan. This building will be so designed that space for club facilities can be taken in it as needed. The officers of the Engineers Club believe that the new building will provide desirable office space for engineers on account of its central location and the conveniences of the club.

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Portland, Oregon, July 15-17.

CANADIAN GOOD ROADS ASSOCIATION, annual meeting, Charlottetown, P.E.I., September 1-3.

PUBLIC WORKS CONGRESS, joint meeting, AMERICAN SOCIETY OF MUNICIPAL ENGINEERS AND INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Toronto, Ont., September 28-30.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, Royal York Hotel, Toronto, Oct. 1-2, 1936.

AMERICAN WATER WORKS ASSOCIATION, NEW YORK SECTION, fall meeting, Saratoga Springs, N. Y., Oct. 22-23, 1936.

COLORADO ENGINEERING COUNCIL selected the following officers: president, Frank H. Prouty; vice president, Park B. Carpenter; secretary-treasurer, Charles A. Davis.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, New York, N. Y., Sept. 22-25.

Personals

STEPHEN TIMOSHENKO, professor of engineering mechanics at the University of Michigan, was awarded the degree of Doctor of Science by Lehigh University on June 9.

LT.-COL. CHARLES L. HALL, for the past four years district engineer in charge of the Cincinnati office of the United States engineers, will be transferred on Sept. 1 to Fort DuPont, Del., to take command of the 1st Regiment, Corps of Engineers.

ROBERT F. HERDMAN has been appointed by the Bureau of Reclamation to the post of resident engineer in charge of construction at Bartlett Dam, a concrete multiple arch structure on the Verde River near Phoenix, Ariz. Mr. Herdman, previous to his government work, was connected for a number of years with the Byllesby Engineering & Management Corp. of Chicago.

WILLIAM L. FEDDON, vice-president and consulting engineer of the Seaboard Air Line Ry., retired from active service on June 16. Mr. Feddon had been associated with the Seaboard for 37 years.

W. N. GLADSON, dean of the school of engineering of the University of Arkansas for the past 23 years, has submitted his resignation, but retains his position as vice-president of the school.

G. P. STOCKER, head of the department of civil engineering for 17 years, will succeed Dr. Gladson as dean of the engineering school.

JAMES M. ROBERT, professor of mechanical engineering, has been elected dean of the college of engineering of Tulane University. Professor Robert will succeed Dean Douglas Anderson, who is retiring from active service at the close of the present session. Professor Robert is a graduate of the college of engineering of Tulane University, class of 1906. He has been associated with the university since his graduation.

P. E. GARNER has resigned as district engineer in the southeastern district of WPA to go into private practice. He has opened an office in Gulfport, Miss. At the present time Mr. Garner is engaged in the design and construction of facilities for the protection of shoreline roads on the Mississippi Gulf Coast, and is also representing several counties in south Mississippi in general engineering practice.

Obituary

COL. EDWARD N. JOHNSON, United States engineer, retired, died in San Francisco, on June 28 at the age of 60.

MAXWELL HYDE, an architect of New York City, died there at the age of 68. Mr. Hyde was a graduate of Columbia University and was for many years, until his retirement in 1934, a member of the firm of Wilkinson & Hyde.

BYRON H. KINGHORN, chief highway engineer of the province of New Brunswick, Canada, died on June 27 at the age of 51. Mr. Kinghorn was a graduate of the University of New Brunswick, and at one time

served on the engineering staff of the National Transcontinental Ry.

MORRIS F. CHENEY, civil engineer of Jamestown, N. Y., died July 1 in Cleveland, Ohio, at the age of 42.

GEORGE A. RUTHERFORD, 65, president of the George A. Rutherford Co., general contractors, died June 29 in Cleveland, Ohio.

EDWIN J. MORRISON, president of the Hastings Pavement Co., and of the International Pavement Co. of New York, died in Yonkers, N. Y., on July 1 at the age of 69. Mr. Morrison was a graduate of Dartmouth College and the Thayer School of Civil Engineering. He had been connected with the Hastings Pavement Co. since 1894.

WILLIAM T. SHEEHY, a civil engineer of New York City, died in New York on July 1 at the age of 34.

LT. CHARLES H. SCHWARTZ, head of the cost section of the Memphis district of the U. S. Engineers, died in Memphis on June 28 at the age of 42.

FREDERICK O. MCLOUGHLIN, professor of civil engineering at City College of New York, died June 28 at Big Indian, N. Y., at the age of 48. Professor McLoughlin had been teaching at City College since his graduation from that institution in 1909.

GEORGE N. RANDLE, city engineer of Oakland, Cal., died in Monrovia, Cal., on June 24 at the age of 63.

THURE B. HANSON, employment manager of the Morgan Construction Co., Worcester, Mass., died in that city on June 29 at the age of 52.

DAVID L. MILLER, aged 82, former head of the building organization of E. Noyes Whitcomb Company, Boston, Mass., died in Hingham, Mass., on June 26. He had retired in 1924.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $60,847,000 for the week, of which $22,299,000 is private work, and $38,548,000 public. Of the public, $14,267,000 represents federal and $24,281,000 state and municipal. Corresponding values a year ago are: Total, $17,913,000; private, $4,230,000; state and municipal, $12,332,000; federal, $1,351,000.

Industrial buildings at $10,957,000 are responsible for the sharp rise in private work. This is the second highest figure they have reached this year. The volume by classes of work is: public buildings, $13,530,000; commercial buildings, $4,625,000; streets and roads, $8,261,000; bridges, $3,817,000; sewerage, $4,275,000; waterworks, $1,655,000; earthwork, drainage waterways $6,157,000; unclassified, $7,570,000.

The larger contracts for the week include: rolling mill for Wisconsin Steel Works, South Chicago, Ill., $2,000,000; breakdown clipping plant, Rainier Pulp & Paper Co., Shelton, Wash., $500,000; power plant, Carnegie-Illinois Steel Co., South Chicago, Ill., $5,000,000; school, Whitesboro, N. Y., $500,000; high school, Pittsburgh, Pa., $750,000; nurses' home and training school, Brooklyn, N. Y., $1,180,000; Cadet Barracks Building and Academic Building, U. S. Military Academy, West Point, N. Y., $2,509,000; superstructure, Rotary Park Housing Project, Oklahoma City, Okla., $1,560,000; post office, Indianapolis, Ind., $1,370,000; highways, by North Carolina, $568,000; by New York, $723,000; by Nebraska, $1,168,000; bridges, by California, $453,000; by Iowa, $699,000 and $994,000; 392,645 ft., 6-24 in. c.i. pipe, Dept. Water and Power, Los Angeles, Calif., $624,000; Wards Island Sewage Treatment Plant, New York, N. Y., Contracts C-1, 2, 3, Contract H, $597,000; Contracts 13 and 14, superstructure Manhattan and Bronx grit chambers, Contracts 15, 17, and 18, heating, ventilating and plumbing, $646,000; Bird Avenue Sewer, Division J, Buffalo Sewer Authority, Buffalo, N. Y., $659,000; Division I, $1,145,000; Bartlett Dam, Bureau of Reclamation, Arizona, $2,228,000; Lock 24, Mississippi River, U. S. Engineer, Clarksville, Mo., $1,636,000; laying and welding 314 miles, 6-10 in. pipe line, Shell Oil Co., Los Angeles, Calif., est. $4,000,000; 20,000 tons steel rails, Chesapeake and Ohio R.R., Washington, D. C., est. $1,750,000.

State and municipal bond sales for the week total $7,637,000 and corporate security issues $10,250,000. This brings the total new capital to $479,905,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average July 1935	Prev. 4 Weeks	Week July 9 1936
Federal Government	$3,826	$8,184	$14,267
State and Municipal	12,285	25,470	24,281
Total public	$16,111	$33,654	$38,548
Total private	5,607	10,865	22,299
Week's total	$21,718	$44,519	$60,847
Cumulative to date:			
1935	$694,613,000	1936	$1,219,689,000

NEW PRODUCTIVE CAPITAL

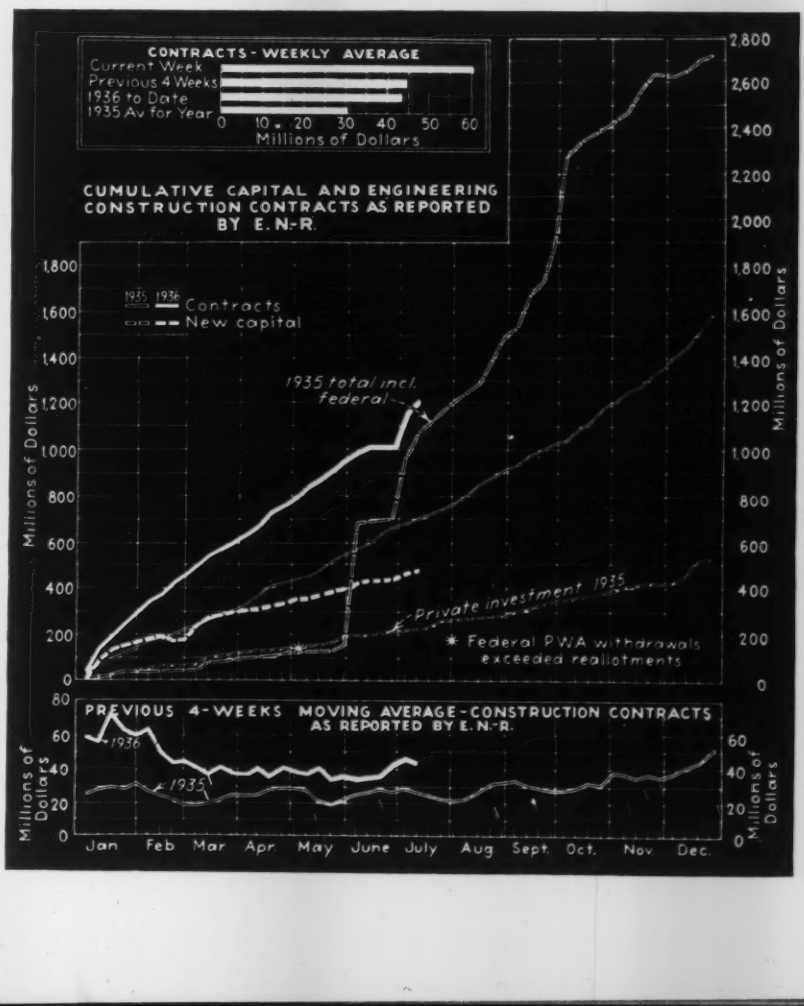
(Thousands of Dollars)

1936	Week July 9	Cumulative
State and municipal	$7,637	$293,287
PWA non-federal	....	32,190
RFC loans	....	12,479
Corporate issues	10,250	133,724
PWA loans, Private	....	3,270
Total Non-Federal	$17,887	$474,950
Federal	....	4,955
Total new capital	$17,887	$479,905
Cumulative to date:		
1935	$954,206,000	1936	$479,905,000

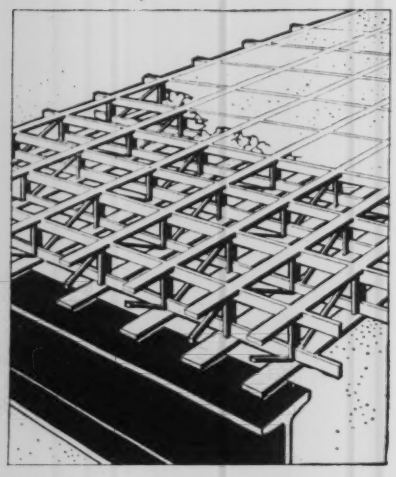
Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
July, 1936	**202.60**	**97.38**	**June, 1936**	**196**	**86**
June, 1936	204.60	98.35	May, 1936	149	65
July, 1935	195.18	93.82	June, 1935	122	54
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1935 1936 Contracts
New capital
1935 total incl. federal
Private investment 1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1936
1935
Jan Feb Mar Apr May June July Aug Sept Oct. Nov. Dec.

Construction Equipment and Materials

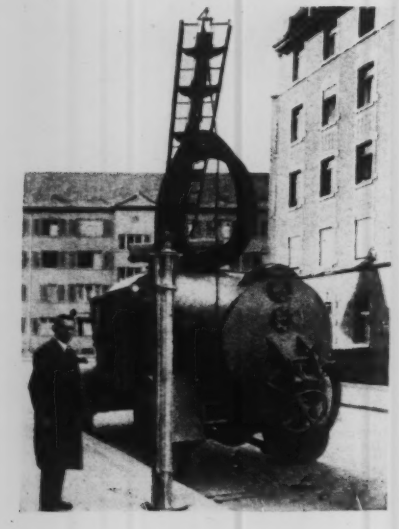


THE KERLOW STEEL COMPANY of Jersey City, N. J., has introduced a light-weight steel floor which is intended to be used either as part of a concrete-filled slab or as an open grill. The flooring is a series of light trusses built up from common bars and shapes and placed perpendicular to the main floor joists. This construction is claimed to give a free flow of concrete in all directions.

Ambidextrous Fire Truck

A fire truck which may be used, when not putting out fires, for cleaning storm drains, draining cellars, watering streets, dredging sand or gravel from streams, and many other types of work where water has to be moved is manufactured by the Sihl Engineering Works, Zurich, Switzerland.

The truck is operated by a Diesel engine, and double step-up gears are used for operating the two centrifugal pumps located behind the driver's cab. The tank on the truck has three containers, one for 220 gallons of fresh water, a container to hold 750 gallons of mud, while the third has a capacity of 265 gallons of mud and water mixed.



In fire fighting, both of the pumps draw from the tank and operate individually, in series, or both at the same time. The fire hose can be used for 12 minutes without the necessity of drawing water from an external source and a low pressure pump feeds water into the storage tank.

An electrically operated crane lowers or lifts the suction nozzle for cleaning out storm drains, and water from the tank is forced through the drain after the mud has been drawn into the tank container. The crane which lifts and lowers the suction nozzle carries a ladder for use in fighting fires or rescuing persons from burning buildings.

Portable Rock Drill

The Ingersoll-Rand Co. has announced a new light weight wagon mounting for rock drills. It is intended to fill the gap between the large drill and the hand-held jackhammer. It will handle 20-ft. steel and will accommodate a 6-ft. steel change. Feed is by air motor with a range of feed pressure from 1 to 1000 pounds. A self-locking worm drive permits feeding the drill up to the rock in the same manner as with a hand crank drill. The mounting can be equipped with pneumatic tires.

New Equipment in Brief

Adjustable Drafting Table—A drafting table which is claimed to be extremely adjustable and light in weight is manufactured by the Drafto Co., of Cochranton, Pa. The board is clamped to chrome plated loops that telescope into the legs of the frame. Table height can be adjusted from 32 in. to 40 in. The table can be tilted from horizontal to vertical on either side. The complete table weighs 30 lb.

Street Lamp—A horizontal filament, a tubular bulb, and a bi-post base have been introduced into the 4,000 lumen, 6.6 ampere, street series lamp manufactured by the Westinghouse Lamp Company, Bloomfield, N. J. The new design is claimed to give more accurate focusing and better control of light.

Recent Publications

If you use washers, ask the **Wrought Washer Mfg. Co.** of Milwaukee for their new slide rule for determining weights of washers. It will figure the area and weight per 1,000 of washers made of almost anything from aluminum to oak. . . . **Joseph T. Ryerson & Sons,** of Chicago, has a new 192-page *Data Book* full of tables for the user of steel. In addition to the usual table of weights of standard shapes, it contains interesting tables showing the properties and treatment of various steels. . . . Hot from the presses comes a handsomely printed and illustrated 58-page booklet describing in detail the equipment and operations at **Bethlehem Steel Co.'s** (Bethlehem, Pa.), new strip mill at Lackawanna. The title is *Bethlehem Sheets and Strips*. . . . **Harnischfeger Corp.**, of Milwaukee, has put specifications and a complete description of their P&H electric shovel into *Bulletin X-9*. . . . The *Handbook of Wires and Cables*, issued by the **Anaconda Wire & Cable Co.**, of New York City, tells you in 15 pages what cable to put where. . . . **The Trane Co.**, of LaCrosse, Wis., has described and given technical data on their air conditioning equipment in a 7-page pamphlet. *The Trane Climate Changer*. . . . *Link-Belt Power Transmission Equipment* is a new 203-page catalog of the **Link-Belt Co., Chicago**. . . . **Yale & Towne,** Philadelphia, catalog their hoisting equipment in a new 20-page pamphlet. . . . **Worthington Pump & Machinery Corp.,** of Harrison, N. J., have an abbreviated catalog (16 pages) in which they describe *Worthington Equipment for the Contractor*. . . . A 15-page booklet, succinctly entitled *Dredges,* describes the many types of dredges built by the **Dravo Contracting Co.,** of Pittsburgh. . . . A new method of bonding asphaltic paving into corrugated pipe is described by the **Armco Culvert Manufacturers Association,** of Middletown, Ohio, in a 10-page booklet entitled *Asbestos Bonding*. . . . The **Pennsylvania-Dixie Cement Corp.,** of New York City, has compressed into the 7 pages of their pamphlet, *Concrete Tables and Recommended Mixes,* tables showing quantities of material in various mixes. . . . A 12-page illustrated Catalog of *Unusual Mechanical Lifters* is put out by the **Lewis-Shepard Co.** of Watertown, Mass. . . . **Worthington Pump & Machinery Corp.** have described and cataloged the *Worthington Compressors* in three pamphlets of 8 pages each. . . . **The Kawneer Co. of Niles,** Mich., show 54 pages of store fronts in *The Book of Store Fronts.*